THE

Transactions

OF

The Royal Society of South Australia

(Incorporated.)

Vol. XLV.

CRINOIDS FROM THE CRETACEOUS BEDS OF AUSTRALIA, WITH DESCRIPTION OF A NEW SPECIES.

By PROFESSOR WALTER HOWCHIN, F.G.S.

[Read April 14, 1921.]

PLATE I.

The Crinoidea are only sparingly represented in beds of Cretaceous Age in Australia. Up to the present time there has been only one species determined, and this only reported from two localities, both of which are in Queensland (1) The muddy character of the Cretaceous sea in this part of the world appears to have been unfavourable for the development of this class of organisms. It is now my privilege to submit to the Society brief descriptions of three additional examples, including a new species.

PENTACRINIDAE.

Genus ISOCRINUS, Von Meyer

ISOCRINUS AUSTRALIS (Moore)

Pl. i., figs. 1 and 2.

Pentacrinus australis, Moore, Quart. Journ. Geol. Soc., xxvi., 1870, p 243, pl. 17, fig. 3; pl. 18, fig. 1.

Pentacrinus australis, Eth. fil, Cat Austr Foss., 1878, p. 105.

Pentacrinus australis, Eth. fil , Geol. and Pal. Q'land, etc., 1892, p 439, pl. 20, figs. 1-3.

Isocrinus australis, Eth. fil., Dept. of Mines, Q'land, Geol. Sur Bull., No. 13, 1901, p. 6, pl. 1, fig. 4; pl. 3, figs. 1-3.

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(1) It is unfortunate that in each instance where the remains have been described no columnals have been present, which is a distinct loss in the way of determination. Moore says, "In a block from Wollumbilla a portion of a column, with 95 regular joints, is present, of probably the same species" *(loc. cit.)*. It is to be regretted that these were not figured.

In 1869-70 Charles Moore described and figured a number of fossils that had been collected in Queensland by the Rev. W. B. Clarke, among which were two examples of crinoids contained in calcareous nodules obtained at the Amby River, Mitchell Downs, and which were named by Moore, *Pentacrinus australis*. One of the specimens exhibited the base of the pelvis with the lower portions of three arms and the basal stumps of two others. The other specimen, from the same locality, shows the interior of the pelvis with truncated portions of several arms extending from it.

In 1892, Robert Etheridge, jun., in his "Geology and Palaeontology of Queensland" (p. 439), reproduces Moore's descriptions and plates, but no further examples had, at that date, been found.

Subsequently, the late Mr. George Sweet, of Melbourne, made a valuable collection of Cretaceous fossils in Queensland, which was placed in the hands of Mr. Etheridge for determination, the publication of which forms Bulletin No. 13 of the Geological Survey of Queensland. In Sweet's collection there were two specimens of crinoids which were referred by Etheridge to Moore's species, *P. australis*, but subsequently, following the lead of F. A. Bather (Nat. Science, xii , 1898, p. 245) in his redefinition of the genus *Pentacrinus*, Etheridge placed the Queensland specimens under *Isocrinus*, Von Meyer. The specimens, like those described by Moore, are much crushed and imperfect. Etheridge concludes that *Isocrinus australis* possessed five radials supporting as many rays or arms, and these latter were each divided at a higher level into two, and then, each of these divided arms was again forked at least seven times, or fourteen times to each radial. In no case has a radial arm, or brachium, been found complete, but it is considered that the arms must have been, at least, 8 in. in length.

I have now the pleasure of recording the occurrence of two more examples of this species. The specimens were received by the President (Sir Joseph Verco) from Mr. M. W. Hackendorf, late of Stuart Range, and were obtained from the precious opal deposits of that locality. The specimens form pseudomorphs in precious opal, but are coated with a thin superficial layer of a ferruginous kind which obscures the opaline structure. As the specimens are more or less covered by small circular-shaped lichens, they must have formed surface stones on the outcrops. The two specimens are of about equal size and character and consist of portions [illegible] brachia, or arms, which have been broken off at the [illegible] near their basal connection, with the respective calices or cups. The length of the larger example extends to only 1½ in., and the other is a trifle smaller. There are the remains of five arms in each specimen, consisting of the lower portions, and the longest fragment shows twelve brachial plates, or ossicles The arms are three-tenths of an inch in diameter, uniserial, and nearly circular in transverse section. There is no bifurcation present, as the arm-fragments are too short to show forking. The several features of the specimens from Stuart Range, so far as shown, are in all respects similar to those of *Isocrinus australis*, and I have no doubt that they belong to that species.

ISOCRINUS PARVUS, n. sp.

Pl. i., fig. 3.

In 1909 Mr. A. S. Giles forwarded to the Adelaide Museum a small piece of limestone, of Cretaceous Age, containing crinoidal remains, and stated that the specimen had been obtained from a locality 20 miles north of Macumba Creek. The specimen was courteously placed in my hands for examination. The fragmentary condition of the remains did not offer much encouragement in the way of description, so that the specimen has remained undescribed until the present. The discovery of two additional examples of *Isocrinus australis*, described above, made it desirable that, in recording their occurrence, some notice should be taken, at the same time, of the examples obtained near Macumba Creek.

The crinoidal remains obtained from the last-named locality are included in a piece of shelly limestone, of flattened shape, 2½ in. in diameter: the fossils, which are of a fragmentary character, are exposed on both the flat faces, as well as the edges, of the stone. The remains are limited to brachia and pinnules, affording only scanty data for specific determination; but the rarity of fossils of this type in the Cretaceous beds of Australia and its manifest distinction from the hitherto only known Australian species of this age, may be assigned as sufficient reasons for the present restricted and imperfect diagnosis.

Def.—Stalk and cup unknown. Arms bifurcate equally (isotomous). Brachial plates, uniserial; rectangular in vertical figure and suboval in transverse outline; destitute of striae; with ambulacral grove on ventral side; minutely perforated, centrally. Pinnules numerous. Distinguished from *I. australis* by its greatly inferior size.

As previously stated, the remains are restricted to brachia and pinnules. These are represented by 21 fragments, probably representing more than one individual, especially as some of the fragments lie in reversed positions to each other. The arm-fragments are imperfect at each extremity, so that it is impossible to define the position which they severally occupied in the crown. The largest example, present, has a length of 2 in. The lower portion of this fragment consists of five ossicles, each deeply niched at half distance. An axial joint marks the beginning of bifurcation (the only one seen on the slab), beyond which the brachial ossicles are somewhat reduced in size, but are equal to each other in the respective branches, and destitute of the divisional niche seen in the plates below the point of bifurcation. There are 28 brachials in one branch and 35 in the other—neither are complete.

In the case of the lower limb (below bifurcation) the ossicles measure one-tenth of an inch in diameter, but those in the limbs above the axial joint gradually taper to a fourth of the original size. This would lead us to infer that the specimen shows the last fork in the arm and the respective rays, thus formed, would be finials. All the arm-fragments seen on the stone are closely pinnulated, and the latter extend along the entire length of those exposed.

The specimen agrees with the genus *Isocrinus* in the characteristic feature of its isotomous bifurcation, but is distinguishable from *Isocrinus australis* by its relatively small size. The type specimen has been placed in the National Museum, Adelaide.

DESCRIPTION OF PLATE I.

(All objects of natural size.)

Figs 1 and 2. *Isocrinus australis* (Moore). Pseudomorphs in precious opal. The light-coloured portions show the opaline interior where the surface "skin" has been removed by abrasion. The darker portions represent the ferruginous coating of the specimens.

Fig. 3. *Isocrinus parvus*, n. sp. Brachia, probably finials, showing pinnules and isotomous bifurcation.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA.
No. 19.

By J. M. Black.

[Read April 14, 1921.]

Plates II. to IV.

This paper deals principally with collections made in the Far North by Mr. H. W. Andrew in July and August, 1920, by Professor J. B. Cleland in country about 80 miles north of Renmark and about 5 miles from the New South Wales border in January, 1921, and by myself at various points on the East-West Railway as far west as Ooldea at the end of September, 1920.

Three new species, in the genera *Salicornia*, *Calandrinia*, and *Calotis*, are described and figured.

The reference to "districts" indicates a new record for any of the botanical districts into which South Australia is divided in Prof. Tate's Flora.

An asterisk indicates an alien species domiciled here.

Gramineae.

Eragrostis Dielsii, Pilg. Mount Gunson (Mrs. Beckwith); Port Augusta West; Gawler Ranges (Dist. W). Stems often prostrate.

E. laniflora, Benth. 80 miles north of Renmark (Dist. W; J. B. Cleland).

Amphipogon strictus, R. Br. Murray scrub near Mannum (Dist. M; H. Griffith); 80 miles north of Renmark (Dist. M; J. B. Cleland).

Cyperaceae.

Schoenus aphyllus, Boeck. Eighty miles north of Renmark (J. B. Cleland). The spikelets examined contained 2 flowers, the lower one bisexual with 5-7 stamens, and the upper one (enclosed in a small hyaline glume) male with 3-6 stamens.

Juncaceae.

Juncus maritimus, Lamk., var. *australiensis*, Buch. Bank of Torrens Lake, Adelaide.

Liliaceae.

**Asparagus officinalis*, L. "Common Asparagus." Renmark; "growing wild along the irrigation channels" (J. B.

Cleland).—Europe. Recorded in Victoria by F. M Reader in the Journal of Pharmacy as long ago as 1887 as a garden escape (Ewart, Weeds Vict., 72)

CASUARINACEAE.

Casuarina lepidophloia, F v. M. Tarcoola; Wynbring; Ooldea (Dist W, J. M. B.) "Black Oak" Seventy miles north of Renmark (J. B. Cleland). A tree 5-6 m. high, with erect-spreading branches; cones smaller than in *C. stricta*, and the valves (bracteoles) pubescent on the back; bark rough, dark brown and fissured, especially near the base; sheathing teeth 9-12. I have seen in the Tate Herbarium a specimen of the type, "from between the Darling and Bogan Rivers." It has slender branchlets (1 mm. diam. when dry), minutely hoary, and 9-10 ciliate teeth. Our specimens seem to agree with the type except that the branchlets are sometimes a little stouter (1½ mm. diam., dry) and that the number of teeth varies from 9 to 12.

LORANTHACEAE.

Loranthus miraculosus, Miq. Eighty miles north of Renmark (flowering January on *Myoporum platycarpum*; J. B. Cleland); Ooldea (flowering February; Mrs. D. Bates). Umbel 2-4-rayed, flowers all sessile; petals and style deep-red, the former usually 5, sometimes 4 or 6, 15-20 mm. long (much longer than in the description of the type); leaves always obtuse and tapering towards the base, usually nerveless, when very broad sub-3-nerved.

L. linophyllus, Fenzl. Eighty miles north of Renmark (J. B. Cleland). Flowering in January on *Acacia Burkittii*.

SANTALACEAE.

Three species of *Fusanus* are found along the East-West Railway as far west as Ooldea: *F. acuminatus*, R. Br., the edible native peach or quandong, sometimes only a shrub 2-5 m. in height, with a drooping scarlet fruit often 3 cm. in diameter and a deeply pitted endocarp, *F. persicarius*, F. v. M., the inedible quandong, with a mesocarp thinner and bitter to the taste, and the endocarp nearly smooth; *F. spicatus*, R. Br., the "fragrant sandalwood," with thick, usually obtuse leaves, an inedible fruit which remains green, a smooth endocarp, and very fragrant flowers, which make their appearance from May to July.

CHENOPODIACEAE.

Kochia triptera, Benth. Fl. Aust. v., 185 (1870). Tarcoola (J. M. B.). Vertical wings 4-5. The more specimens

I see the more I feel convinced that *K. decaptera*, F. v. M., Fragm. ix., 75 (1875), cannot be maintained even as a variety. Most of our South Australian specimens have 4-5 vertical wings on the fruit, but at Stuart Pass (Tate Herb.) and at Broken Hill, N S.W., specimens are found which have normally 3 wings, but occasionally 4 or even 2 wings; sometimes, where there are apparently only 3 wings, abortive fourth or fifth wings are present. Other specimens from Broken Hill, similar in all other respects to the above-mentioned, have 4 or 5 vertical wings. *K. pentatropis*, Tate, in Trans. Roy. Soc. S. Austr., vii. 67 (1884), was later on united by its author with *K. decaptera*.

K. triptera, var. *erioclada*, Benth. Between Mounts Parry and Playfair (Tate Herb. as *K. pentatropis*); Dublin (H. Griffith), Leigh Creek and Tarcoola (Dr. Cannon); north of Murat Bay and Port Augusta West (J. M B.).

K. villosa, Lindl., var. *tenuifolia*, Benth. Eighty miles north of Renmark (J. B. Cleland). Appears to be a rather stiff, erect, almost glabrous shrub or under-shrub; perianth-tube hemispherical with 10 slender ribs.

K. pyramidata, Benth. Tarcoola (Dist. W; J. M B.).

Bassia Tatei, F. v M. Farina and Murnpeowie (Dist. C; H. W. Andrew). The Tate Herbarium contains the following specimens: the type collected in 1883 by Prof. Tate near Lake Torrens, but not described by Mueller until 1890; Cootanoorinna (near Warrina, coll. M. Murray, without date); Mount Lyndhurst (Max Koch, 1898, and described by the collector as "a perennial plant with upright branches, grey-tomentose").

B. sclerolaenoides, F. v. M. Beltana (H. W. Andrew). Here the 5 spinelike appendages are wanting, and only the 5 herbaceous, bifid or sometimes trifid appendages are present, so that the fruiting perianth resembles externally those of *K. ciliata* and *coronata*.

Threlkeldia inchoata, J. M. Black. Todmorden Station, Alberga River (H. W. Andrew).

Th. salsuginosa, F. v. M. Port Augusta West (Dist. W; J. M. B.). It now seems to me preferable to place the wingless species under *Threlkeldia*, and to retain *Babbagia* for the winged species, according to Mueller's original definition of the genus (Rep. Babb. Exped. 21), instead of uniting the gibbous-fruited and wing-fruited species under *Osteocarpum*.

Rhagodia Gaudichaudiana, Moq. Tarcoola (J. M. B.). A fair-sized straggling shrub growing near the creek; leaves soft, all hastate; flowers in a dense panicle; berry scarlet; fruiting perianth 5 mm. diam. when closed over the fruit, 8 mm. across when spread open after the fruit has fallen; testa black pitted.

Rh. Billardieri, R. Br. Ooldea Soak, flowering and fruiting in September (Dist. W; J. M. B.).

Atriplex Muelleri, Benth. Todmorden Station, Alberga River (Dist. C; H. W. Andrew).

A. limbatum, Benth. At Port Augusta West I collected a form in which the fruiting bracteoles are of the normal length (10-12 mm.), but the broad spreading interior lobes of the bracteoles are reduced to a short membrane terminating at each end in 2 small erect horns much shorter than the 2 erect toothed outer lobes or appendages. The fruiting bracteoles resemble those of *A. leptocarpum*, and this form emphasizes the close relationship which exists between the two species.

A. crassipes, J. M. Black in Trans. Roy. Soc. S. Austr., xlii., 171, t. 16 (1918). This name must be reduced to a synonym, as a comparison with specimens in the Tate Herbarium proves it to be the same as *A. elachophyllum*, F. v. M., Fragm. vii., 8 (1869). The type was collected by Mueller in the "desert of Sturt Creek," N.T. My specimens came from Marree (Hergott). Those in the Tate Herbarium are from Lake Weatherstone (west of Lyndhurst Railway Station, 1883, R. Tate), and Birksgate Range (1891, R. Helms).

Salicornia pachystachya, n. sp. (Tab. ii.) Fruticulus humilis, caulibus primo suberectis denique prostrato-radicantibus, ramis ascendentibus saepius oppositis, sterilibus articulis 5-15 mm. longis 3-6 mm. crassis saepe rubellis, lobis inconspicuis appressis, spicis 12-25 mm. longis, floriferis 4-6 mm. crassis viridibus, fructiferis 7-8 mm. crassis rubrobrunneis, fertilibus articulis 4-10, floribus in singulis semiverticillis plerumque quinis, summis saepe ternis, inferioribus rarissime septenis, omnibus bisexualibus diandris proterogynis, perianthio primum succulento deinde duriusculo duobus lobis latissimis et brevissimis vel paene rimâ simplici longitudinali hiante, pericarpio hyalino, semine suborbiculari compresso exalbuminoso circiter 1¼ mm. diametro, testâ chartaceâ stramineâ margine papillosâ faciebus rugulosâ, endopleurâ et embryone *S. australis*. Floret ab Augusto ad Novembrem, fructificat a Novembri ad Januarium.

South Australia. Near mouth of Patawalonga River (Glenelg); Port Elliot (J. M. B.).

Victoria. Lake Tyrrell (per H. B. Williamson).

Western Australia. Near Perth (C. Andrews, Nos. 706, 707). I have not seen these specimens, but the Director of the Kew Gardens states that they quite agree with samples of *S. pachystachya* forwarded to that establishment.

Differs from *S. australis*, Banks et Sol., in its shorter and thicker spikes, fewer fertile articles, stamens constantly 2 in each flower, flowers usually 5 in the half-whorl, and in the outer seed-coat, the hairs on the margin of which are straight, obtuse, and so short that they can only be termed papillae. It grows along with *S. australis* on the banks of the Patawalonga River, but usually further back from the brackish tidal water. The flowering period is much earlier; in 1920 at Glenelg *S. pachystachya* had ripened almost all its seeds before there was any sign of flowering on *S. australis*. As the 2 species were combined in my description of *S. australis* in these Trans., xliii., 365 (1919), it will be well to enumerate here the points of difference:—

S. australis.	*S. pachystachya.*
Spikes 15-60 mm. long; 4-5 mm. thick, diameter not increased in fruiting.	Spikes 12-25 mm. long, when ripe 7-8 mm. thick.
Fertile articles 10-20.	Fertile articles 4-10.
Flowers usually in 7's, often in 5's or 3's in the upper articles, rarely in 9's in the lower articles, and very rarely all in 5's.	Flowers usually in 5's, often in 3's in the upper articles, very rarely in 7's in the lower ones.
Testa covered on the margin with long hooked hairs.	Testa papillose on the margin.
Flowers November-March; fruits April-May.	Flowers August-November; fruits November-January.

Observations made at Glenelg show that *S. pachystachya* is proterogynous. This does not agree with European experience of the genus, judging by the statement of Volkens in Engl. u. Prantl, Nat Pflanzenfam. iii., 1a, 48 (1893). He says: "Was die letztere (Dichogamie) angeht, so besteht Proterandrie ganz sicher bei den *Beteae* und *Salicornieae*, Proterogynie ebenso bei den *Chenopodieae* und *Suaedeae*." In *S. australis*, on the other hand, the anthers protrude before the styles in the truly bisexual flowers, but there seems to be a tendency towards unisexualism, the upper flowers of the spike having often sterile pistils, while the lower ones have often sterile stamens, or perhaps in some cases none at all. In both species the perianth opens by two lobes so short and broad that the opening appears little more than a vertical or longitudinal slit in the centre of the truncate summit.

S. quinqueflora, Bunge. Through the kindness of the Director of the Royal Botanic Gardens, Kew (Sir D. Prain) I have received the original description of this species from Ungern-Sternberg's monograph "Versuch einer Systematik der Salicornieen," p. 59 (1866). From this it appears to have been correctly identified as a synonym of *S. australis*, Banks et Sol. Part of the description reads: "Maximallänge der Aehren 10¼-20 mm.; Maximaldicke der Aehren 2¼-3¼ mm.; Samenhärchen ziemlich lang, angedrückt, an der Spitze zurückgekrümmt oder-gerollt." It is true that the number of flowers is given as 5, but short-spiked specimens of *S. australis* occur sometimes in which all the flowers of the spike are arranged in 5's. The specimens on which Bunge's species were founded came from Port Adelaide (Blandowsky, F. Mueller); Melbourne (Hillebrand); Port Jackson (Rieder).

Halocnemum australasicum, Moq. This species must, judging by the descriptions, have some affinity with *Arthrocnemum Lylei*. *Halocnemum* is described as having a "perianthium *tripartitum*" (Bentham and Hooker), "perigonium triphyllum" (Moquin), and the albuminous seed of *Arthrocnemum*. *A. Lylei* differs in the perianth not tripartite but 3-lobed near the summit, more slender spikes, and also in the seed-coat. The type of *H. australasicum* was not seen by Bentham and was only shortly described by Moquin. By the courtesy of Prof. Lecomte, of the Paris Museum of Natural History, the type has been re-examined, and the following particulars, which may prove useful to botanists who seek to rediscover this plant at King George Sound, W.A., have been obtained: "épi floral long de 2½ à 3½ cm., large de 5 â 7 mm.; il est conique-cylindrique, obtus au sommet; la graine ovale, oblongue, noire est aplatie, bordée tout autour de tubercules coniques, allongés, blanchâtres, disposés sur 5 à 6 rangs; le milieu de la graine a de petites épines noirâtres."

Arthrocnemum halocnemoides, Nees, var. *pergranulatum*, J. M. Black. Patawalonga River, Glenelg. Observations made on the typical form at Ethelton, on the Port Adelaide River, go to prove that this species has proterandrous flowers.

Suaeda australis, (R. Br.) Moq. (*S. maritima*, Benth. non Dumort.) Port Adelaide River and seacoast near Adelaide. Perennial, 50-80 cm. high; leaves light green; plano-convex; flowers in distinct clusters and then 3-5 in each axil, or in continuous clusters (a dense, leafy spike), with 4-9 flowers in the axil, often female only with abortive stamens; fertile stamens exserted; flowers and branches usually becoming purplish-red.

PHYTOLACCACEAE.

Gyrostemon ramulosus, Desf. Ooldea Soak (J. M. B.). A shrub 2-4 m. high, growing in sandy soil, with spreading branches; bark corky and brittle; wood when dry extraordinarily light in weight; locally known as "Christmas Bush" on account of its evergeen appearance.

PORTULACACEAE.

Calandrinia disperma, n. sp. (Tab iii.) Herba annua, caulibus diffusis usque metrum longis, foliis carnosis clavatis subcompressis, radicalibus 1-4 cm. longis caulinis brevioribus, racemis paucifloris paniculam formantibus, pedicellis fructiferis deflexis demum sub calyce sursum curvatis et incrassatis, floribus parvis inconspicuis, petalis 4-5 sepala obtusa 1 mm. longa parum superantibus post anthesin calyptram efficientibus, staminibus 4-5 basi in annulum coalitis nec petalis ejusdem floris numero plerumque aequalibus nec iis oppositis, styli ramis 3, ovulis 2, capsulâ conico-cylindricâ circiter 5 mm. longâ sexcostatâ basi in modum tori columnae subito ampliatâ apice velut per porum apertâ alioqui non dehiscente, seminibus 2 pyriformibus superpositis comparate magnis (1½-2 mm. longis) nigris nitentibus basin versus granulatis, radiculâ superâ.

Flowering and fruiting in sandy ground at Ooldea in September (J. M. B.). Nearest to *C. corrigioloides*, F. v. M., both in the long capsule and in the fewness of ovules and seeds. Differs in the longer and stouter stems; more numerous stamens; fruiting pedicels much longer, spreading, curved upwards and thickened under the calyx; capsule of firmer consistence, not opening by valves, swollen at the base like the torus of a column; and especially in the comparatively large pear-shaped seeds, granular towards their base, suspended from long funicles which rise from the base of the capsule and are bent over in the upper part, somewhat after the manner of those of the section *Basigonia* of *Frankenia*. Following the shape of the seed, the embryo is not perfectly annular and the superior (epitropous) radicle extends considerably beyond the cotyledons. In all the flowers examined I have found only 2 ovules, and normally both these ripen into seeds.

C. polyandra, (Hook.) Benth. The common parakeelya at Tarcoola and other places in the sandhill country as far west as Ooldea appears to be this species and not *C. balonnensis*, Lindl. The styles (3, rarely 5) are quite free and stigmatic in their whole length; stamens 40 to 50, in 2-3 rows united in a ring towards the base; anthers from ovoid to oblong; petals large, showy, red, 5, rarely 6; peduncles swollen at base; pedicels reflexed in fruit; seeds minute (½ mm. diam.), copper-coloured, concentrically granular. A white-flowered form grows at Ooldea Soak. Mueller at one time expressed the opinion (Fragm. i., 177, ann. 1859) that *C. polyandra* scarcely differs from *C. balonnensis*, but later, in his 1st and 2nd Census, he kept them separate.

I have specimens from the River Finke, N T. (S. A. White), and there is a similar one from Chambers' Pillar in the Tate Herbarium, with stouter stems than the parakeelya of the East-West Railway and much larger seeds (1 mm. diam.), dark-coloured and concentrically granular; anthers narrow-oblong. These are the true *C. balonnensis*.

C. pleiopetala, F. v. M., although the number of petals probably varies considerably, seems to be well distinguished by its small amber-coloured smooth shining seeds, and I have specimens with this character from Mount Gunson (Mrs. Beckwith), and Koonowarra on Cooper Creek (S. A. White). From *C. calyptrata*, Hook. f., which has also smooth shining seeds, but larger and dark red, *C. pleiopetala* differs in its stouter, probably perennial growth, much larger flowers, and numerous stamens.

C. pusilla, Lindl., varies much in size but is a smaller plant with smaller flowers than *C. polyandra*. The colour of the petals varies from purple to pure white. The stamens are usually 7-10, but in an Ooldea specimen I found them to vary between 6 and 12. Mueller says (Fragm. x., 68) that he has sometimes seen the flowers with 20 stamens. The seeds are minute (½ mm. diam.), copper-coloured or almost black, and concentrically granular, but in spite of the wrinkling of the surface they shine with a metallic lustre.

CRUCIFERAE.

Blennodia curvipes, F. v. M. Murnpeowie (Dist. C; H. W. Andrew). "Sweet-scented and plentiful locally."

Thlaspi cochlearinum, F. v. M. Murnpeowie (Dist. C; H. W. Andrew).

Stenopetalum sphaerocarpum, F. v. M. Tarcoola (J. M. B.). Growing in sand; stems lying prostrate in a circle.

Lepidium leptopetalum, F. v. M. Eighty miles north of Renmark (J. B. Cleland). The petals, longer than the sepals, tapering into a point at the summit and twisted, at least when dry, are practically those of the genus *Stenopetalum*, with which this species forms a connecting link.

CRASSULACEAE.

Crassula colorata, (Nees) Ostenf. (*Tillaea acuminata*, Reader). Port Augusta; growing with *C. Sieberiana*.

LEGUMINOSAE.

Leschenaultia divaricata, F. v. M. Redbanks, near Murnpeowie. (Fruiting, August, 1920; H. W. Andrew). The Tate Herbarium contains a flowering specimen from Anna Creek, coll. M. Murray, April, 1885.

Acacia ligulata, A. Cunn. Meteor bore, near Murnpeowie; near Mount Lyndhurst Mine (H. W. Andrew)

A. Sowdeni, Maiden, in Journ Roy Soc., N.S. Wales, liii., 180, t. 11 (1920). Park-lands of Port Augusta, near the Roman Catholic Cathedral (flowering September; J. M. B.). A handsome shrub 2-5 m. high, with abundance of flowers and several stems, rough brown fissured bark and drooping branches. The type was collected here by Mr. J. H. Maiden during a visit to South Australia in January, 1907. Tarcoola (September; J. M. B). I considered this to be a desert form of the same species, but Mr. Maiden, to whom specimens were submitted, has doubts as to their identity and thinks the Tarcoola plant may be *A. Loderi*, a Broken Hill species which he has recently described The phyllodes are narrower than in most of the specimens collected at Port Augusta, being usually 1½-2 mm. broad. The inflorescence and flowers are the same, but no pods have yet been obtained. My field note at Tarcoola says· "Tree with large butt, branching near base, 6-7 m. high, the upper branches spreading and drooping; bark rough, whitish." It also grows further west along the East-West Railway, and is locally known as "myall."

A. Burkittii, F. v. M. Eighty miles north of Renmark (Dist. M; J. B. Cleland). This species is well known in the Broken Hill district, N.S W., but has not, as far as I know, been hitherto recorded from any part of South Australia except the typical locality near Lake Gilles, E.P.

A. tarculensis, J. M. Black. Tarcoola (J. M. B.). To the particulars already published, the following field note may be added:—A dense glaucous shrub, 1-2 m. high, almost globular in shape, the spreading stems rising from the base of the plant, which is clothed with foliage down to the ground Growing near the old town of Tarcoola, beside the creek in front of the Tarcoola Blocks Mine, and on the plain. Pods not yet ripe (September 20), curved, 4-8 cm. long, about 1 cm. broad, flattish, thick on the margin, not constricted between the seeds, covered by a close golden or reddish tomentum. Seeds not fully developed but apparently oblique.

A. brachystachya, Benth. Wynbring. A neat, compact shrub or tree, about 4 m. high, of grey appearance owing to the colour of the foliage; pods beginning to ripen in September, numerous, 3-5 cm. long, almost flat.

ZYGOPHYLLACEAE.

Zygophyllum Howittii, F. v. M. Murnpeowie (flowering August; H. W. Andrew). Mueller's types were in fruit and he does not mention the number of stamens. In all my specimens I found them to be 6 only—3 opposite the 3 glands at the base of the 3-celled ovary and 3 alternate with the glands. Thus in this species the number of stamens is twice as many as the ovary-cells, and does not depend on the number of sepals and petals, which is 4. The anthers are almost globular, and the filaments are slightly dilated towards the base but not winged. The glands are fleshy, ciliolate at summit, quite distinct from each other, united very slightly to the base of the ovary, and doubtless represent the disk. The yellow petals scarcely exceed the sepals, both being about 2 mm. long. The ovules are 2 in each cell, suspended, with a ventral rhaphe, and a superior micropyle. Tate in his Flora, and Koch in the MS. note to his specimens in the Tate Herbarium, state that the number of stamens is 8, but a careful examination of the material—from Lake Torrens Plain (Tate) and Mount Lyndhurst run (Koch)—proves the number to be only 6. The same is true of Tate's specimens from Crown Point, Finke River, N.T. The lower stem-leaves are often entire.

Z. Billardieri, DC., var. *ammophilum*, J. M. Black. Tarcoola. Petals white, shorter than sepals; stamens 8; fruits small.

EUPHORBIACEAE.

Euphorbia australis, Boiss. Near Mount Bayley, about 5 miles north of Beltana (H. W. Andrew). This appears to be a rare or at least localized species, and in this respect it contrasts with the ubiquitous *E. Drummondii.*

Adriana (?)*Hookeri*, (F. v. M.) Muell. Arg. Ooldea Soak, where it is known as "Water Bush," owing to the belief that water may be struck below the soil where it grows (J. M. B.). This seems to be a different species from *A. tomentosa*, Gaudich., which was found by Capt. White in January, 1917, at the Ooldea condensers—a shrub only 60 cm. high, with broad leaves (3-5 cm. long by 2-3 cm. broad), cordate at base, and often 3-lobed. The shrub at the Soak is over 1 m. high, has oblong-lanceolate leaves 3-5 cm. long and 1-2 cm. broad, not 3-lobed or cordate at base, but coarsely crenate and narrowing abruptly into the petiole. The styles are very shortly united at the base, but the leaves are too large for typical *A. Hookeri*. In both plants the female flowers are almost solitary. F. v. Mueller united *A. Hookeri* with *A. tomentosa*. The specimens from Ooldea Soak agree very closely with some in the Tate Herbarium collected by R. Helms in the Victoria Desert, W.A., and placed under *A. tomentosa.*

**Eremocarpus setigerus*, Benth. Fields near Glenelg (per E. H. Ising). A Californian weed, strongly scented and covered with bristly stellate hairs, not hitherto recorded. Called "woolly white drought-weed" in California and (among the Spanish-speakers) "yerba del pescado," because the Indians used to employ it to stupefy fish in small streams (Jephson, Fl. West. Mid. Cal. 245).

SAPINDACEAE.

Dodonaea attenuata, A. Cunn. Yadnarie, E.P. (Dist L; per A. G. Edquist); Port Augusta; Ooldea Soak (J M. B.). Shrub 1-2 m. high, with rough brown bark.

MALVACEAE.

Sida cryphiopetala, F. v. M. Near Oodnadatta (Miss Staer). This appears to be the first record of this species for South Australia proper. Tate only gives it for his Dist. F, which is in the Northern Territory.

S. calyxhymenia, J. Gay. Tarcoola.

Hibiscus Farragei, F. v. M. Eighty miles north of Renmark (Dist. M; J. B. Cleland).

FRANKENIACEAE.

Frankenia pulverulenta, L. Foreshore at Geelong, Vict. (H. B. Williamson, 1908). This identification has been confirmed by Mr. E. Surgis, of the Paris Museum of Natural History, who is engaged on a revision of the *Frankeniaceae*. He adds that it agrees in all points with the European plant and with specimens brought to France by the Baudin Expedition of 1801 from the east coast of Australia, also with two others collected by Max Koch in South Australia in 1899. Max Koch's researches were principally made near Mount Lyndhurst (Flinders Range), so that the plant probably exists in that district. Having been discovered so early in the history of Australia it seems not unlikely that this Mediterranean species is also indigenous here. Among our endemic species it stands nearest to *F. pauciflora*, DC., both in the flowers, placentation, and number of ovules, but differs altogether in the shape of the leaves, which are flat, obovate, truncate, or almost emarginate, and covered below with very short white hairs which gave the surface a mealy appearance.

F. fruticulosa, DC., collected at Murat Bay (Thevenard Peninsula), has sometimes 3 placentas and 3 style-branches, but in such cases I have only found 1 ovule to each placenta.

MYRTACEAE.

Melaleuca glomerata, F. v. M. Rep. Babb. Exped. 10 (1859).

M. hakeoides, F. v. M., ex Benth. Fl. Aust. iii., 151 (1866).

These two species were afterwards united by Mueller in his Census, but Bentham, in the Flora Australiensis, kept them separate, and E. Cheel, in Ew. and Dav. Fl. N.T. 303 (1917), distinguishes them by the size of the leaves It seems to me that an examination of the flowers supports the specific distinction. The flowers of *M. glomerata* were unknown when Mueller's and Bentham's descriptions were written

Leaves slender, 1-1½ mm. broad; staminal bundles 3-4 mm. long, filaments 3-5; claw ¾-1 mm. long, much shorter than the petal. . . . *M. hakeoides.*

Leaves stouter, 2-2½ mm. broad; staminal bundles 6 mm. long, filaments usually 7, sometimes 6 or 8, claw 2 mm. long, equalling or slightly exceeding the petal. . . . *M. glomerata.*

The localities for South Australia are as follow:—

M. hakeoides. Aroona Range (R. Tate); Dalhousie Springs, Moolooloo, Petermorra Springs (S. A. White); Nuccaleena (E. H. Ising); Murnpeowie, Blanchewater Creek (H. W. Andrew). The type came from "N.S. Wales. Mount Goningberi, near Cooper Creek. *Victorian Expedition.*" (Benth. Fl. Aust. iii., 151.) The "Victorian Expedition" is the name applied by Bentham to the Burke and Wills Expedition of 1860-61, and "Mount Goningberi" is the Mount Koonenberry of modern maps, situated near the route of the unfortunate explorers and about 120 miles north-east of Broken Hill. The collector was Dr. Hermann Beckler, botanist and medical officer of the expedition.(1)

M. glomerata. Leigh Creek (R. Tate); Glen Ferdinand, Musgrave Range (S. A. White); Mount Ilbillie, Everard Range (S. A. White). Mueller gives the type localities as Lake Gregory, Arcoona, Lake Campbell; collector, D. Hergolt. The "Lake Gregory" of Babbage's Expedition is South Lake Eyre, and not the Lake Gregory of modern maps. This species has a white "paper-bark"; I have no record of the bark of *M. hakeoides.*

Eucalyptus intertexta, R. T. Baker. Mount Patawurta, near Moolooloo (E. H Ising). Maiden (Crit. Rev. Euc. iv., 171, ann. 1919) has already recorded the occurrence of this gum in South Australia at the following places:—Murray Desert; east of Hawker and Umberatana (Flinders Range); Mount Ilbillie (Everard Range); Mount Watson (Birksgate Range).

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(1) Not to be confused with Dr. Ludwig Becker, "artist, naturalist, and geological director" of the expedition, who died at the Bulloo Camp, in Queensland, just beyond the border of New South Wales, on April 30, 1861. Dr. Hermann Beckler was also at this camp, in charge of the sick. He had, along with Landells, tendered his resignation in September, 1860, but at request of Burke "he agreed to remain in charge of the stores at Menindie until arrangements could be made to forward them to Cooper Creek." He returned from Bulloo to Menindie with Wright (the third officer) in May, 1861. Dr. L. Becker drew and lithographed several of the plates for Mueller's "Plants indigenous to the Colony of Victoria" (1860-62).

E. microtheca, F. v. M. Murnpeowie Creek (H. W. Andrew). This is the most southerly record for South Australia, although in New South Wales it has been collected near the Barrier Range.

E. dumosa, A. Cunn. At Ooldea Soak a large "white mallee," with fruits 6 mm. in diameter; at the 407-mile Station (next to Ooldea) a small mallee 1½-2 m. high, with fruits 8-9 mm. diameter. In both cases the points of the valves are so much exserted that at the first glance the specimens might be pronounced *E. oleosa,* but the buds, of egg-in-egg-cup shape, with truncate ribbed opercula, oblong anthers opening in longitudinal slits, and fruits not contracted at the orifice determine the species. Also collected by Dr. Cleland 80 miles north of Renmark.

E. oleosa, F. v. M. Between Ooldea Railway Siding and Ooldea Soak. "Water mallee," so called because the natives obtain water from the roots; known to the natives themselves as "nabbari" or "ngabbari," and further north it is called "nabbara" or "abbara."

This is the form which Mr. J. H. Maiden described in 1911 (Journ. W.A. Nat. Hist. Soc. iii., 171) as var. *glauca,* and in 1919 (Journ. Roy. Soc. N.S. Wales liii., 58) raised to specific rank as *E. transcontinentalis.* He distinguishes it as having glaucous leaves, "buds with elongated opercula about twice as long as the calyx-tube, and which are somewhat constricted, particularly on drying." I have specimens from Moolooloo and Leigh Creek (Flinders Range), Tooligie and Donald Plain, E.P., the Musgrave Range, also from the MacDonnell Range, N.T., all with whitish leaves and acuminate opercula considerably longer than the tube, often twice as long, but other specimens from Quorn southwards to Maitland, Y.P., and Enfield, and eastward to the Murray Scrub have similar flowers with long acuminate opercula, but green leaves. My field note on the specimens from the Murray Scrub states: "leaves lanceolate, dark green on both faces."

Thryptomene Whiteae, J. M. Black. Specimens collected by me at Wynbring, East-West Railway, with more mature and ribbed calyxes, prove that this name must be reduced to a synonym of *Th. Elliottii,* F. v. M. I have been allowed an opportunity of examining the type of *Th. Elliottii,* which was collected by E. Giles between Ooldea and Charlotte Waters, and is now in the National Herbarium of Victoria.

UMBELLIFERAE.

**Bupleurum semicompositum*, L. Murray Bridge (A. R. Hilton).

SOLANACEAE.

Solanum chenopodinum, F. v. M. A specimen from Murnpeowie (H. W. Andrew), just beginning to flower (July), with short, sometimes branched extra-axillary racemes bearing about 7 flowers, ovate-lanceolate leaves, sinuate towards the base and hastate or even cordate, green and sprinkled with stellate hairs above, lighter coloured and more densely tomentose below, appears to be this species.

S. coactiliferum, J. M. Black. Wynbring, East-West Railway (J. M. B.); 80 miles north of Renmark (E. B. Cleland).

S. hystrix, R Br. Ooldea (Mrs. D. Bates). Native name "walga walga."

**S. rostratum*, Dun. Murray Bridge (per J. F. Bailey). Previously recorded from Bute.

Duboisia Hopwoodii, F. v. M. Renmark (Dist. M; E. C. Black); 80 miles north of Renmark (J. B. Cleland).

MYOPORACEAE.

Eremophila Latrobei, F. v. M., var. *Tietkensii*, J. M. Black. Ooldea (J. M. B.). Corolla deep pink.

E. maculata, F. v. M. Ooldea (J. M. B.). The corollas are sometimes pure white.

COMPOSITAE.

Calotis ancyrocarpa, n. sp. (Tab. iv.) Herba glabrescens verisimiliter annua, caulibus erectis dichotome ramosis, foliis caulinis linearibus vel anguste oblanceolatis 5-25 mm. longis integris vel breviter ac remote paucidentatis, floribus radii 25-30 albis, capitulis fructiferis globosis circiter 6 mm. diametro, achaeniis complanatis glabris, alis lateralibus basi valde ampliatis sursum incurvatis (ancorae formam simulantibus) breviter ciliatis, pappi aristis 12-20 retrobarbellatis inter se inaequalibus sed universim achaenio fere aequilongis.

Murteree, Strzelecki Creek (S. A. White, September, 1916). Recorded in these Trans. xli., 648, as a form of *C. multicaulis*. Capt. White, in his field note, says: "Growing in tufts on the flooded ground 4 or 5 inches high." Our two specimens do not show the base of the plant, which differs from *C. multicaulis* and *C. porphyroglossa* in the narrower leaves and chiefly in the ripe achene, which is glabrous except for the short ciliation of the wings; the wings much broadened at the base and incurved upwards so as to each form a deep sinus and present a hooked or anchor-like appearance. In its foliage the new species bears a close resemblance to *C. pterosperma*. The inset figures (4, 5, 6) show that in their fruits these three last-named species stand much nearer to one another than to *C. ancyrocarpa*. Bentham states that *C. porphyroglossa* has a pappus of numerous barbed awns but in my specimens from Alberga Creek I have only been able to find 4-7 awns. For *C. pterosperma* Bentham gives "8 to 10 very short awns"; in Robt. Brown's type (kindly lent me by Mr. J. R. Tovey, officer in charge of the Victorian National Herbarium), I found 4-6 awns ½ mm. or less in length.

C. multicaulis, (Turcz.) J. M. Black. Tarcoola (Dist. W; J. M. B.). Leaves rather broader, shorter, and less toothed than in the far-northern specimens, but the achenes are the same and the ray is white.

C. erinacea, Steetz. Bentham (Fl. Aust. iii., 502) says: "achenes with 3-5 awns." In very dry country such as our North-West or Far North (Port Augusta, Nilpena, Ooldea, Everard Range, and Finke River, N.T.), or even as far south as Ardrossan, the number of awns is usually only 2, but the achene is easily distinguished from that of *C. cymbacantha*, because in the latter species the 2 awns are separate, strongly barbed, and placed at right angles to the compressed tuberculate faces of the achene, while in *C. erinacea* the 2 awns are united in a cup at the base, are very slightly barbed, and placed parallel to the compressed faces of the smooth achene. In a Renmark specimen I have found some achenes with as many as 8 awns, 2 of the normal broad awns being each replaced by 3 smaller awns. Specimens in the Tate Herbarium from Ideyaka have 8 or even 9 awns. The type (from Swan River) had 4 awns: "aristis 4 subaequalibus achaenium laevissimum aequantibus obverse aculeatis" (Steetz in Pl. Preiss. i., 424). Similar specimens with 4 or sometimes 3 awns united in a cup at the base are from Renmark, Lake Perigundi, and in the Tate Herbarium from the MacDonnell Range, N.T., and the Barrow Range, W.A.

Leptorrhynchus tetrachaetus, (Schlecht.) combin. nov. (*L. pulchellus*, F. v. M., in Linn. xxv., 500, ann. 1852; *Doratolepis tetrachaeta*, Schlecht., in Linn. xx., 593, ann. 1847). Nov. var. *penicillatus*. Variat pappi setis 1-3 superne plumoso-penicillatis, pedunculi squamis inferne herbaceis in folia caulina transientibus.

Marree, Leigh Creek, Tarcoola (J. M. B.); Strzelecki Creek (Tate Herb.). This appears to be a dry-country form of the species. The pappus resembles closely that of *Athrixia* *tenella*. In some specimens both the few female and the numerous bisexual flowers have only 1 pappus bristle. In outward appearance the variety can be distinguished from the type only by the scales of the peduncle, which are not wholly scarious, but herbaceous in the lower part, and thus pass gradually into the stem-leaves.

Cratystylis conocephala, (F. v. M.) S. Moore. Eighty miles north of Renmark (J. B Cleland)

Cephalipterum Drummondii, A. Gray. (Plate ii.) Tarcoola, Barton, Ooldea. A common plant along the East-West Railway, covering considerable areas with its snow-white flower heads. Diels and Pritzel (Fragm. phyt. Aust. occid. 615) divide this species as follows:—

1. Forma minor capite universo 1-1·5 cm. diam., pappo exteriore deminuto.

2. Forma major (typica autoris) capite universo 2·5-5 cm. diam., pappo exteriore conspicuo.

All the plants which I collected at the places above-mentioned were of the smaller form, but the type appears also to exist in our State, as I have specimens with the large compressed heads gathered by B. S. Jobson in 1918 at some station stated to be east of Ooldea. The difference in the scale or outer pappus in the two forms is easily discernible. In the type (fig. 1 of the plate) it is a small ovate ciliate membranous unilateral extension of the border of the achene; in the smaller form (fig. 2) it is very short, thick, fleshy, and so inconspicuous that it is rather difficult to recognize. In the innermost sterile flowers of both forms it is quite obsolete. The scale is situated on the inner or posterior face of the achene. The hairs of the outer achenes are of two kinds. Those which occupy vertically the outer face of the achene are seen under the microscope to be twisted spirally (figs. 1, 2, 3), but when moistened they often unroll from the base and show that each apparently simple hair consists of two hairs coiled round each other, loosely in the lower part and tightly towards the summit. These are distinct in character from the long intricate hairs which cover the inner face and sides of the achene and which are furnished with hooked barbs towards the end (figs. 1, 2, 4). The pappus proper, or inner pappus, consists of 3-6 erect bristles rising inside the very obtuse border which crowns the achene. These bristles are almost plumose in the upper part and penicillate at the summit. As the bristles fall off almost at a touch, even before the achene is ripe, it is evident that they serve no purpose except to protect the flower. The dispersal of the fruits is probably effected by animals, as the long flexuose hairs of the achene have small hooked branches near their extremities, and the hairs on the outer face have the faculty of coiling.

Angianthus brachypappus, F. v. M. Ooldea, half-mile west of the siding and on the edge of the Nullarbor Plain (Dist. W; J. M. B.). My field note says: "Plant with prostrate stems and short ascending branches; leaves rather thick, compressed horizontally; compound heads conical, yellowish, the vertical rows of partial heads usually twisted spirally as flowering proceeds." In comparing this species with *A. tomentosus*, Wendl., it should be noted that while the latter has 2 conduplicate and 2 inner flat sessile bracts to each partial head, *A. brachypappus* has 3 outer bracts, subherbaceous and rigid in the lower half and placed on the lower or outer side of the partial head, and 1 flat sessile hyaline bract, after which come the 2 lateral conduplicate bracts and 2 inner clawed flat bracts, or 8 bracts in all to each partial head. The anthers have no tails. This species is recorded in Tate's Flora only for his S district, and in these Trans. iv., 107 (1882), he gives the localities as Kanyaka, Wonoka, and Edeowie, but there is no specimen in the Tate Herbarium. In the Flora Australiensis the only locality given for South Australia is "North-West interior, MacDouall Stuart's Expedition." The name does not appear in either of Mueller's lists of the plants collected on that expedition, but the site was probably near the MacDonnell Ranges, N.T. Mueller (Report Babbage's Expedition, 13) gives for this species the locality of Stuart Creek; D. Hergolt, collector. This creek is a little south-west of Lake Eyre and in Tate's Dist. C.

Gnephosis skirrophora, Benth. Ooldea (Dist. W; J. M. B.).

Helichrysum Lawrencella, F. v. M., var. *Davenportii*, Benth. Specimens collected by me at Ooldea have ripe achenes distinctly beaked and varying from pubescent to scabrous with short stiff hairs, most of which wear off in time. The pappus bristles of the outer fertile flowers are forked, sometimes twice, plumose from the base but merely barbellate towards the summit; those of the inner sterile flowers are similarly plumose and barbellate, but are not branched.

H. Mellorianum, J. M. Black. East-West Railway, 407-mile Station, near Ooldea. The number of heads in the cluster varies from 4 to 12.

Helipterum roseum, (Hook.) Benth., var. *patens* (Ewart), combin. nov. Variat parvitate omnium partium plantae, caulibus circiter 8 cm. longis, involucri bractearum intimarum laminis albis tantum 4-5 mm. longis ovatis potius quam lanceolatis.

Ooldea, July, 1920 (Mrs. Daisy Bates). Very different in appearance from the typical form, with long pink or white rays, so frequently cultivated in gardens. There are two similar specimens in the Tate Herbarium collected by R. Helms in the Fraser Range, W.A., October 4, 1891, and labelled "*H. Troedelii*, F. v. M., var. *patens*, A. J. Ewart." In the Proc. Roy. Soc. Vict., xxii. (n.s.), part 1, 15 (1909), where the varietal name is published, the localities given are "Mount Lyndhurst, M. Koch, No. 1644, 1899; Fraser Range, W.A., R. Helms, 1891." This plant differs from *H. Troedelii* in its glabrous character, the shape of the involucre and its radiating laminae, the greater number of flowers in the head, the more numerous pappus bristles, penicillate and golden at the summit and not united in a tube. In all these respects it agrees with *H. roseum*. It is probably the form of that species "capitulis parvis" mentioned by Diels and Pritzel (Fragm. phyt. Aust. occid. 628) as having been collected on the Victoria Plains, W.A. They also observe that *H. roseum* is very variable in size and colour of flowers. The varietal name is not appropriate in respect of *H. roseum*, but it must be retained under art. 48 of the Vienna rules.

H. Humboldtianum, (Gaudich.) DC. Ooldea (J. M. B.). First record for South Australia of this species, of which the type was gathered in Western Australia. It cannot be the closely allied species *H. Haigii*, F. v. M., described from specimens collected near Eucla, because our plant has pubescent achenes and only the outer involucral bracts are woolly. It is a handsome everlasting, the inner bracts having small obtuse golden radiating laminae. The number of flowers in the head is 12-14 and the pappus-bristles 14-15.

H. Tietkensii, F. v. M. Eighty miles north of Renmark (J. B. Cleland). Flowers in head only 6-7; pappus-bristles 18-20.

Senecio dryadeus, Sieb. The existence of this species in South Australia seems to be only an assumption. Bentham in the Flora Australiensis quotes in his list of localities: "South Australia. Loddon River, *F. Mueller*." This river is of course in Victoria, and is situated more than 150 miles east of our border, as the crow flies. Mueller, in his 1st Census of Australian Plants (1882) gives *S. australis*, A. Rich. (*S. dryadeus*, Sieb.), for South Australia. In his Key to the system of Victorian plants (1887-8) he locates *S. dryadeus* in his SW District, which extends as far west as "the vicinity of the Glenelg River." There is no mention of the species in any of Tate's lists of South Australian plants until the year 1883, when in his "Additions to the Flora of

South Australia" (Trans. Roy. Soc. S. Austr., vi., 113) *S. australis*, A. Rich., is located "near the Glenelg River, *F. v. M.*" Then in his Flora of Extra-tropical South Australia *S. dryadeus* is quoted for the Mount Gambier District. It is well known that Mueller was in the habit, when a plant was found within 10 miles or so of the boundary of one State, of transferring it to the flora of the adjoining State, on the assumption that it would be found growing there also. There is no mention of the plant either in Tate's own "list of unrecorded plants in the south-east part of this colony" (Trans. Roy. Soc. S. Austr., vi., 95-99, ann. 1883) or in Eckert's list of plants growing in South Australia between the Glenelg River and MacDonnell Bay (Proc. Aust. Ass. Adv. Sc., v., 410, ann. 1893). There is no specimen in the Tate Herbarium, nor have I seen one from any part of our State. Until a specimen is actually found it would therefore be safer to delete the species from the South Australian flora.

Podolepis capillaris, (Steetz) Diels. Tarcoola (J. M. B). Flowers pure white, the inner ones with 2 of the corolla lobes more deeply cut than the other 3; the 5 arranged digitately on one side of the staminal tube.

P. acuminata, R. Br. Gladstone (Dist. N; J. M. B.); Pinnaroo (Dist. M; from local public school).

Waitzia acuminata, Steetz. (*W. corymbosa*, Benth., non Wendl.) This handsome golden everlasting is common near Tarcoola and Ooldea. The laminae of all the involucral bracts are reflexed when the head is in full flower, with the exception of those of the innermost bracts, which are very short and uncoloured. Diels and Pritzel point out (Fragm. phyt. Aust. occid. 625, ann. 1904) that F. v. Mueller stated in the Zeitschrift des allgemeinen österreichischen Apotheker-Vereins, vol. 50, p. 934 (1896), after examining Wendland's type in the Steetz Herbarium, that *W. corymbosa*, Wendl., is really the plant described by Bentham as *W. nivea* and is quite distinct from *W. acuminata*, Steetz, with which Bentham had confused it. Mueller thus confirms the correctness of Steetz's arrangement in the Plantae Preissianae. Maiden and Betche make the correction in their Census of New South Wales plants, but attribute the discovery to J. G. Luehmann.

**Aster subulatus*, Michx. Recorded on insufficient material as *Erigeron canadensis*, L., in these Trans., xxxv., 2 (1910), xliii., 354 (1919). When fuller material was obtained it became evident that this identification was incorrect and specimens were sent to Kew with the result mentioned above. A North American plant with habitat from New Hampshire to Florida. It seems to have established itself in South

Australia, having been found at Renmark, Murray Bridge, Pompoota, and quite recently within the City of Adelaide, on wet ground along the north bank of the Torrens Lake, near the University boatshed, where it often reaches a height of nearly 2 m. The minute ligules of the corolla, which even at the time of flowering are no longer than the pappus, give it the appearance of an *Erigeron*, but the involucral bracts are in 4-5 rows. Also established in Victoria and Queensland. Described in American floras as an annual, but often survives at least two years here.

DESCRIPTION OF PLATES.

PLATE II.

Salicornia pachystachya, n. sp. 1, stem and fruiting branches. 2, budding spike. 3, summit of flowering perianth. 4, vertical section of perianth, showing pistil and 2 stamens. 5, fruiting spike. 6, withered spikes, showing cavities after fruits have fallen. 7, seed. 8, transverse section of seed; *t*, testa; *epl*, endopleura; *rad*, radicle; *cot*, cotyledons.

Cephalipterum Drummondii, A. Gray. 1, outer flower (of the large headed typical form; drawn from a specimen collected by A. Oldfield at Champion Bay, W.A., and lent to me by Mr. Tovey, officer in charge of the Victorian National Herbarium); *sq*, the scale, or "outer pappus." 2, a ripe achene, viewed from above and showing the thickened, obsolescent scale *(sq)* of the smaller form. 3, one of the "coiled hairs" (really 2 hairs coiled spirally round each other). 4, one of the long, flexuose, barbed hairs. 5, outer involucral bract. 6, inner spreading involucral bract. The complete plant and all the other figures except No. 1 represent the small-headed form *(forma minor* of Diels and Pritzel).

PLATE III.

Calandrinia disperma, n. sp. 1, a flowering and fruiting branchlet. 2, calyx spread open. 3, corolla spread open. 4, pistil. 5, ovary spread open. 6, vertical section of capsule. 7, embryo and albumen within the membranous endopleura; *e*, embryo; *alb*, albumen. 8, embryo; *rad*, radicle; *cot*, cotyledons.

PLATE IV.

Calotis ancyrocarpa, n. sp. 1, ray flower. 2, disk flower. 3, ripe achene. 4, 5, 6, ripe achenes of *C. pterosperma*, R. Br., *C. multicaulis*, (Turcz.) J. M. Black, and *C. porphyroglossa*, F. v. M., respectively.

GEOLOGICAL MEMORANDA (SECOND CONTRIBUTION).

By PROFESSOR WALTER HOWCHIN, F.G.S.

Subjects

I. Miniature Serpuline "Atolls."

II. Pseudo-Cryptozoön Structure.

III. A Prehistoric Alluvial Fan of Exceptional Character at the Mouth of the Glen Osmond Gorge.

IV. The Occurrence of Scoriaceous Boulders in the Ancient Gravels of the River Torrens.

[Read May 12, 1921.]

PLATES V. TO VII.

I. MINIATURE SERPULINE "ATOLLS."

Pl. V.

Professor L. V. Pirsson, in the Text Book of Geology by Pirsson and Schuchert, has figured and briefly described [*loc. cit.*, Part I., p. 180, fig. 152] some small atoll-like formations that occur on the coasts of the Bermudas. The explanation given of the figure is as follows:—"Serpuline Atolls, Bermudas Islands. These structures, formed in shallow waters, may be a number of feet or yards in diameter and are locally called 'boilers.'"

Interesting examples of a similar kind occur on the coast, at Encounter Bay, South Australia. The littoral zone, at the locality mentioned, is very shallow and takes the form of a marine platform which extends a considerable distance seawards. This submerged shelf has been cut out by the waves in the Permo-carboniferous glacial till, while large erratics, washed out from the latter, are strewn along the beach and occur abundantly in shallow water of the sea margin.(1) The bay is largely land-locked, being sheltered by the outlying islets of Granite Island, Seal Rock, and Wright Island, as well as by the promonteries of Victor Harbour, at the north-east angle, and Rosetta Head, at the south-west.

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(1) Howchin, "The Glacial (Permo-Carb.) Moraines of Rosetta Head and King Point," Roy. Soc. S. Austr., vol. xxxiv. (1910), pls. vii. and viii.

On account of this protected position the tidal currents are very weak and are scarcely noticeable within the limits of the bay, while the fluctuations of the sea are largely controlled by the direction and force of the wind, the rise and fall of the sea at any time being limited to a few inches. These conditions are very favourable for the development of a littoral fauna, among which *Serpulae* make a prominent feature, forming a kind of miniature fringing reef, composed chiefly of the calcareous tubes of these annelids, with a tendency to assume circular outlines.

Professor Pirsson offers no explanation as to the reason why the serpuline growths on the Bermudas coast take a circular form of growth, but, so far as the Encounter Bay examples are concerned, I think an explanation is possible

The Permo-carboniferous till, which forms the cliffs and marine platform at Encounter Bay, consists chiefly of an argillaceous sand-rock that is easily acted upon by the sea, and yet is sufficiently coherent to form a definite floor. It extends inland throughout the Inman and Hindmarsh Valleys, across the Bald Hills watershed to the shores of Gulf St Vincent, yielding, in many places, excellent sections. Within the body of this argillo-arenaceous till, in many places, there has been a segregation by some cementing agent that has taken the form of a thin layer, or shell, having a spherical outline. In weathering, this layer, being somewhat more resistent to change than the rest of the stone, protects the included portions, which thereby stand out in relief as rounded objects They can be seen in the cliffs of the River Inman, nearly opposite the 8-mile post, and are known, locally, as the "pots and boilers," having the same popular name as the serpuline forms in the Bermudas. They also occur in the washouts, caused by small streams, in the sea cliffs between Port Elliot and Victor Harbour, where they were pointed out to me as "fossil pumpkins."

There is scarcely an appreciable difference in the composition of the material contained within the spherical shell as compared with the general matrix of the till. The nature of the cementing material which gives rise to this thin spherical crust was not critically examined, but it is probably of a ferro-siliceous kind, such as is often developed in concentric lines and as "iron balls" in argillaceous sediments. So far as observed, the size of these so-called "boilers" varies from about a foot to two feet in diameter.

There is little doubt that the serpulite rings that occur in the shallow water of the coast at Encounter Bay take their rise from this spherical structure which is developed in the local till beds. Inland, where these objects are seen in section in the cliff faces, they exhibit a ring in relief. At Encounter Bay, the waves in cutting their way through the sandy till have truncated these spherical bodies, and as the outer and inner portions of the matrix are softer than the spherical crust, the former are denuded, leaving the indurated investment as a circle in relief.

This gives us the explanation desired. The hard and raised circles give better holding-support to the *Serpulae* than the softer ground around, the annelids become attached to the stony circles, and from such a foundation build up their colonies, the calcareous ring offering a certain likeness, in a small way, to the coralline atolls, while the water, filling the depressed centres, gives the similitude to the central lagoon in such islands.

II. PSEUDO-CRYPTOZOÖN STRUCTURE.

Ref. Howchin, "The Occurrence of the Genus *Cryptozoön* in the (?) Cambrian of Australia," Trans. Roy. Soc. S. Austr., vol. xxxviii., 1914, pp. 1-10, pls. 1-5.

At the Ordinary Meeting of the Society, held on April 11, 1918, some rock specimens were exhibited by Mr. L. K. Ward, Government Geologist, that had been collected by Mr. Winton from the New Burra Mine.(2) The specimens were obtained in limestone and contained certain wavy and concentric structures that have, in some instances, a close resemblance to those of the supposed fossil known as *Cryptozoön*. I have recently visited the locality and now offer a few remarks on the nature of the specimens and the geological conditions under which they occur.

The journey was made down the Burra Creek which takes its rise about a mile above Kooringa, but the proper watershed is in the ranges to the north of the township. The creek flows in a south-easterly direction and finds its outlet, when heavy rains occur, in the River Murray, at the Nor'-west Bend. The creek below Kooringa follows a moderately straight course and is heavily charged with alluvial sediments. A course was followed down the creek for nine miles. A series of whale-back limestone ridges follow the western side of the creek, with the main ranges visible beyond. The limestone belongs to the Brighton Series, while the eastern side of the creek consists of the underlying Tapley Hill banded slates. The strike of the beds is roughly parallel with the Burra Creek. At about nine miles from Kooringa, the beds are thrown to a position transversely to the former strike, causing the limestone to cross the creek, and it then follows the top of the range on the eastern side, in a return direction. The beds are, apparently, faulted and repeated along the strike.

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(2) Trans. Roy. Soc. S. Austr., vol. xlii., 1918, p. 297.

At the main angle of disturbance there is a great intrusion of quartz dykes and veins, and the limestone, which follows the eastern ridge, is extensively penetrated with a dark-coloured chert. The chert sometimes occurs in bands several inches in thickness, but, for the most part, in fine laminae, and follows the grain of the limestone, producing a finely-laminated cherty-calcareous rock.

In the north-western angle of Section 3 (Hundred of Kooringa), the New East Burra Mine (late Utica) is situated. The lode occurs in the limestone and carries copper sulphides and carbonates thinly distributed through a gangue of calcite and barytes. On the western side of these workings the infiltration of silica, in the form of chert, follows the planes of bedding in a fine lamination, which is locally much contorted and is sometimes concentric in form, suggestive of *Cryptozoon* structure. A careful examination of the ground, however, leaves no room to doubt that this structure is of inorganic origin. The effects of the siliceous infiltration can be traced over a very wide area, from its occurrence in the form of parallel and straight lines; gradually passing, first into a wavy modification of these lines, and then, in places, to a cyclical and concentric structure. These features occur both along, and for many yards across, the strike.

In the case of *Cryptozoön*, the supposed organic structure is quite distinct from the matrix, while in the case under review, the wavy structure is a feature of the rock-mass as a whole and can be explained by a process of metasomatism in which the limestone, along certain layers, has become altered to chert. The immediate cause of such a change can be explained as a consequence of the powerful local strains to which the bedding has been subjected by earth movements, and the introduction of silicated waters.

At the Burra the same limestone shows laminated and imperfect concentric structures, but without the introduction of silica and with a less resemblance to *Cryptozoön*. Cherty inclusions are first noticed in the limestone, along the strike, about a mile to the south-eastward of Kooringa. (See Howchin, "Autoclastic, Intraformational, Enterolithic, and Desiccation Breccias and Conglomerates," Roy. Soc. S. Austr., vol. xliv., pls. 17 and 18.)

III. A PREHISTORIC ALLUVIAL FAN OF EXCEPTIONAL CHARACTER AT THE MOUTH OF THE GLEN OSMOND GORGE.

Pls. vi. and vii.

The piedmonts on the western side of the Mount Lofty Ranges are deeply incised by numerous short streams that are in a juvenile stage of development. These streams are mostly working on rather steep grades, and although the gathering ground is limited they exert considerable hydraulic force when in flood. The Adelaide Plains, which extend from the foot-hills to the sea, have been built up by alluviation brought down by these streams from the hills, and within a few miles from the base of the hills this transported material has a thickness of 400 ft. Numerous bores on the plains show that the sediments vary from a fine unctuous clay to gravel of moderate size. At the exits of the numerous gullies alluvial fans spread out to a greater or less extent and are extended seawards along the principal channels formed by flood waters. These channels are very absorbent and the greater number of the streams finally disappear on the plains at a lower level.

The Glen Osmond Gorge, which opens on to the plains at a distance of three and a half miles to the south-east of Adelaide, has been cut through a compact quartzite, 100 ft. in thickness, with slaty rocks both above and below it. The stream which is responsible for the excavation of the gorge takes its rise on the scarp face of the foot-hills and is one of the minor creeks that drain the western side of the ranges. It follows a line of faulting, with a downthrow on its left bank, and is confined for some distance in a narrow channel by the side of the main road. After skirting the old Glen Osmond quarries near the foot of the hills, it diverges from the road and follows its natural course within banks from 15 ft. to 20 ft. in depth. It crosses the "Cross Roads" near Glen Osmond; passes through the western portion of the public reserve (Ridge Park); crosses the Fullarton Road on the north side of Fisher Street; and continues, confined by small culverts, through Unley, Goodwood, and by a covered channel through the new Agricultural Show Grounds at Keswick. It is dry during most of the year and is simply a channel for flood waters after heavy rains. The present size of the creek is out of all proportion to the nature of the alluvial fan about to be described.

The ground has a gentle slope, in the direction of the creek, from the mouth of the gorge to the Fullarton Road, a distance of about a mile. Within a restricted breadth, the land adjoining the creek is more or less strewn with angular stones, varying in size from a few inches up to several feet in diameter. Near Glen Osmond, large villa residences and highly cultivated grounds have obscured the natural features, but wherever the ground exists in its natural condition large stones can be noted at the surface, usually strongly embedded in the ground. The distribution of large stones follows, in the main, the direction of the creek channel, sometimes best developed on the one side and sometimes on the other. In the Ridge Park, at Glen Osmond, on the western side of the park, there is a conspicuous group of about thirty examples, situated on the right bank of the creek, the largest stone measuring 3 ft. 6 in. in length. They can be seen on a newly laid out road, on the opposite side of the creek, and in paddocks towards Fullarton.

The most important assemblage of these transported blocks occurs on the eastern side of the Fullarton Road, a little south of Fisher Street, fully a mile from their source. They occur in great numbers, some of extraordinary size, on the grounds of Mr. Thomas Baulderstone and adjoining properties. The largest of these transported blocks measured 9 ft. 6 in. long by 3 ft. 6 in. broad, and 2 ft. 9 in. above the ground. This stone probably weighs not less than six tons. Near the above is a large tabular mass giving the measurements 5 ft. 6 in. by 7 ft. embedded almost level with the surface of the ground Another measured 5 ft. long, 4 ft. 6 in. wide, and 1 ft. 9 in out of the ground. Another, irregular in shape, measured 4 ft. 10 in. long, by 3 ft. 5 in. at greatest width, and 2 ft. 10 in. out of the ground In one part of Mr. Baulderstone's paddock there is a group of eight quartzites, close together, each of which Mr. Baulderstone calculated would weigh something like five tons, and there are scores of quartzite blocks that equal 2 ft. or more in length. To relieve the ground of these obstructions to cultivation a hundred, or more, have been dragged to the side of the paddock and form a conspicuous line at the fence. (See plate vii.) From the stones of this paddock Mr. Baulderstone has built his house, outhouses, and enclosing walls, which exhibit stones of unusual size used for such purposes. When this ground was open for selection, no one wanted it, as it was regarded as a quartzite outcrop, and was actually offered for sale as a possible quarry. The circumstances which gave rise to the distribution of such a large number of angular blocks of stone are evidently abnormal and require some geological explanation to account for their presence. Under certain circumstances ice agency might be credited with the transportation of such large stones, but such a view is not supported by any collateral evidences.

In reaching a conclusion the following facts have to be considered:—

(1) The deposit is not an alluvial fan in the ordinary acceptation of the term. A normal fan is built up by a succession of flood deposits of corresponding features as to strength of current and alluvial sediments, forming a succession of fine and coarse sediments; but the Glen Osmond alluviation, now under description, was unique, there was nothing like it before or since in the geological history of the creek. The sections exposed in the banks of the creek exhibit the normal red clay, with occasional beds of sand or fine gravel, typical of the Adelaide Plains, and in no case do large angular blocks of stone show in these sections. This is confirmed by well sinkings in the neighbourhood. Mr. Baulderstone sunk a well on the ground where the stones occur in great numbers, the first 60 ft. was in bluish and reddish clays followed by 10 ft of sand and gravel; no large stones were met with in sinking, nor was bed-rock reached. A well on the adjoining property gave a like result.

(2) The stones consist of quartzites and slates, chiefly the former, and can be definitely identified with beds of a like character that outcrop in the Glen Osmond Gorge.

(3) All the large stones are angular in outline and of indefinite shape, often partly broken on the bedding plane as though wrenched from their bed by strong force.

(4) The stones lie in every possible position and are confusedly mixed. Sometimes a large mass of slate is seen wedged in between two quartzites.

(5) The trail can be traced back from the Fullarton Road, following the general direction of the creek to the mouth of the gorge. Near the Fullarton Road it is about six chains wide.

The only explanation that can be given, consistently with the evidence, is that of a torrential wash of extraordinary force. To carry such a body of stone, including many rocks of from three to six tons in weight, over a low gradient for a mile, seems an almost impossible task for such a small watercourse. The gathering ground is so limited, the rocks are of the hardest kind, and the stream must have spread out far beyond its ordinary banks. We must assume that a cloud-burst, of local extent, but of exceptional intensity, must have acted as the quarrying and transporting agent.

It is self-evident that no such storm has occurred in our neighbourhood since its occupation by Europeans. Whilst this occurrence must be regarded as geologically "recent," it must be referred to a time far anterior to all historical records. The quartzites show a deeply weathered and incised surface quite equal to the exposed outcrops seen *in situ*, and are covered by lichens, and splitting by the action of the weather. Further, the wash now occupies a slight rise in the ground, the land sloping on either side, which would imply that the interval has been sufficiently long to permit of a lateral denudation that has brought the original water level above the surrounding ground

* * *

Since the above was written I have received a letter from Mr. Baulderstone, under date April 29, 1921, to the following effect:—"I am writing you these few lines to let you know that my next door neighbour (Mr. Tonken) is having that stony paddock, adjoining mine, grubbed of stone ready for cultivation. His men are blasting all day and are smashing up all the largest stones, but enough can be seen to make a very interesting exhibit to a geologist. They will probably finish turning the stones up to-day, so if you could come along, say to-day or to-morrow, you would be able to get a full view of about half an acre of the up-turned stones."

I am glad that Mr. Baulderstone has a due appreciation of the scientific interest which attaches to these remarkable stones, so that whilst he has planted the area in which they occur with trees, he takes pains that none of the larger examples are disturbed.

[*Note.*—It has been suggested that the transport of these large stones might be due to a land-slide in the gully which dammed the water back and was followed by a break-away. This might be taken as a plausible alternative in accounting for their presence, but it has its difficulties. The rocks forming the sides of the gully are solid and stable. To effectively block the channel would require sufficient material not only to cover the floor of the valley, but to make an embankment on the opposite side. There is no evidence of such an occurrence as having taken place either as a slide on the face of the cliffs, or remnants of the talus at lower levels.—W. H.]

IV. THE OCCURRENCE OF SCORIACEOUS BOULDERS IN THE ANCIENT GRAVELS OF THE RIVER TORRENS.

Many years ago my attention was called to a clay pit situated between Mile End and Hindmarsh on account of some unusual features that had developed in working the pit. The clay had been used for brickmaking for a number of years and had been worked down to a floor 20 ft. below the surface of the ground. At this depth the clay ceased and a bed of sand and gravel was met with which varied in thickness from 4 ft. to 9 ft. On looking over the gravel I discovered a boulder, about 5 in. in length, which had an open vesicular structure, very similar to scoriaceous lava Its presence under such circumstances seemed unaccountable, so the specimen was laid aside with the hope that at some future time some evidence might be obtained that would throw light on its true nature and origin.

My interest in the subject was revived when, in 1914, Mr F R Zietz placed in my hands a similar water-worn stone which he and Mr Ridgway had obtained from the extensive gravel deposits at Findon, adjacent to the Grange Road, about four and a half miles from Adelaide. Subsequently, Mr Ridgway, who takes much interest in these gravels and their incidental contents, was successful in obtaining several additional examples of a like kind, the largest of which is a subglobular mass, rounded irregularly by river attrition, and measures 32 in. round the longer diameter and 25 in. round the lesser. In each instance the contemporaneity of these vesicular stones with the rest of the pebbles in the bed was evidenced by portions of the adjacent sand and small stones having become cemented to the exterior surface.

The first impression was that these scoriaceous-looking stones were of volcanic origin, as in their general appearance they can scarcely be distinguished from such vesicular lava as occurs in volcanoes of the Mount Gambier and Mount Schank type. The latter localities are, however, too distant to give any probability of these stones having come from such a source. It seemed equally improbable that extrusions of lava existed in the hill regions that formed the hydrographic basin of the River Torrens.

In pursuance of these enquiries it then became necessary to make thin sections for examination by the microscope, and also to submit the stones to chemical analysis. The microscope showed that fusion had taken place and that the vesicular structure arose from this cause, but whilst mineral glass was present, there was an absence of any further evidence of volcanic action of an incidental kind. There could also be detected in the transparent section minute grains of quartz (sand) which had not undergone fusion. Further, when the largest fragment obtained is examined by the naked sight, small pockets can be noted in the mass which are quite distinct from the gas vesicles, and some of these contain earthy matter which must be regarded as portions of the original material which had not undergone fusion.

As the chemical composition of the scoriaceous material was likely to afford some evidences that might be useful for determination, a typical sample was placed in the hands of Mr. W. T. Chapman, Analyst and Assayer at the Adelaide School of Mines and Industries, who kindly undertook to analyse the specimen. The following is the result:—

SiO_2	71·48
Al_2O_3	12·17
Fe_2O_3	1·73
FeO	3·32
MgO	2·02
CaO	3·12
Na_2O	1·06
K_2O	·92
Water at 100° C.	1·45
Water over 100° C.	2·07
TiO_2	·52
MnO	present
	99·86

A vesicular rock, such as those found in the Findon gravels, if of volcanic origin, would probably represent an extrusive lava of basic composition, such as are commonly known as basalts, or allied forms. The chemical analysis, however, as shown above, does not suggest such a relationship. There is an excess of silica as compared with the basaltic group, as well as a low proportion of the ferro-magnesian elements, and also a low percentage of lime. This discordance in chemical composition, as well as the very high probability that there are no extrusive lavas in the country within hundreds of miles of the place where the stones were found, practically negatives the idea of their volcanic origin.

I venture to suggest that these scoriaceous stones have had their origin in bush fires. Some large tree stumps have been known to smoulder for weeks after a bush fire. A little alkaline material in the soil would assist the fusion of mineral substances, and the presence of organic matter in combustion, under superincumbent pressure, might yield the gas necessary for the formation of a vesicular structure. A termite's nest in the soil at the base of a large tree, or within a hollow stump, might be favourable for the formation of stones of this kind.

Other Localities.—Specimens of a simliar kind have turned up from other localities. Many years ago I received a stone of an open and cindery structure sent down from Central Australia, the sender being under the impression that it was a meteorite. Mr. A. Canning, late school teacher at Paskeville, sent me a collection of stones for determination, gathered from the locality, among which was one of a similar vesicular structure. Still more recently Mr. A. N. Mackenzie sent down from Cooper Creek to the Adelaide Museum a large mass of fused earth, half a square yard in extent, which possessed the same characteristics as those obtained from the Findon gravel pits, but it possesses a more open texture and will float in water. The specimen was obtained at Kopperamanna Lake, in the Cooper Creek region.

DESCRIPTION OF PLATES.

Plate V.

Photograph of a group of small "atoll"-like circles formed by *Serpulae*, Encounter Bay, South Australia.

Plate VI.

View of a group of large transported stones, set in alluvium. Mr. Baulderstone's paddock, near Fullarton Road, looking north.

Plate VII.

View of another group, in linear position, looking east. Observe the numerous assemblage of somewhat smaller stones that have been dragged to the boundary fence in middle distance. Mr. Baulderstone's paddock, near Fullarton Road.

Note.—The photographs, now reproduced, were taken before the planting of the ground as an orchard.

THE EXTERNAL CHARACTERS OF POUCH EMBRYOS OF MARSUPIALS.

NO. 2.—*NOTORYCTES TYPHLOPS.*

By F. Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read June 9, 1921.]

For the specimen described here I am greatly indebted to the authorities of the Perth Museum. Unfortunately no details of its provenance are obtainable. In the Perth Museum, Mr. Glauert informs me, there are three examples of *Notoryctes*. All are females. Two belong to the recently described Western Australian form *N. caurinus* (Thos.), whilst

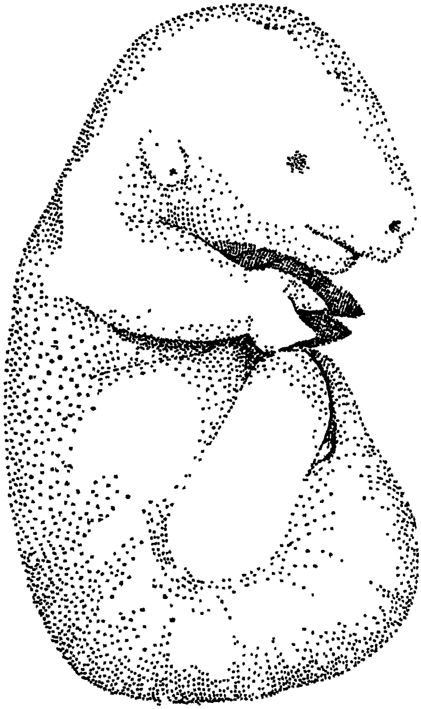

Fig. 1.
Notoryctes typhlops.
Right lateral view of embryo of 10 mm.

the third is the typical *N. typhlops* (Stirling), from Central Australia. It appears certain that the embryo could not have belonged to either of the Western Australian specimens, but beyond that it seems impossible to determine its origin.

The state of preservation of the specimen is not very good, and subsequent microscopical work would not appear to hold out very great promise, but considering the great rarity of embryos of *Notoryctes* it is well to place on record the external characters of even a single embryo, and one, moreover, which lacks a history.

The embryo measures 10 mm. from the vertex to the most distal point of the flexed caudal extremity.

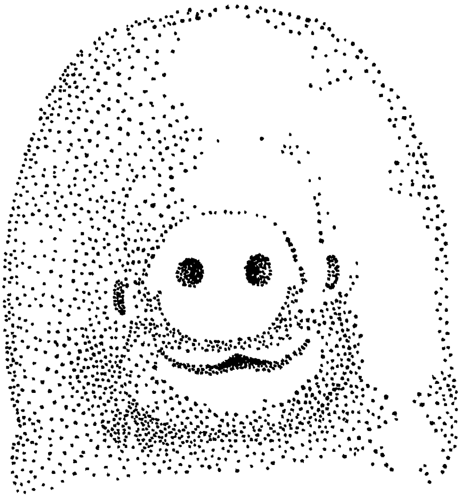

Fig. 2.
Notoryctes typhlops.
Front view of the head to show the features of the rhinarium.

The head is but little flexed on the trunk, but the caudal extremity is flexed in the pelvic, and, again, in the sacral region, so that the tip of the tail is brought beneath the chin.

No trace of hair can be detected, nor are there any skin elevations or sensory papillae present. The eye is well marked as a conspicuous patch of black pigment which shows clearly beneath the covering epitrichium; no trace of eyelids or accessory structures are visible.

The external auditory meatus is situated somewhat far back, behind and below the eye spot; it is surrounded by a definite raised margin which obviously represents the aborted structures involved in the formation of the pinna.

The rhinarium consists of a blunt and pig-like snout at the extremity of which are two rounded narial apertures. The nostrils are situated somewhat wide apart, and their circular orifices open immediately forwards. The narial margins are complete, there being no lateral incisura. The thickening and slight prominence of the dorsal surface of the rhinarium is doubtless the commencing formation of the rhinal shield of the adult.

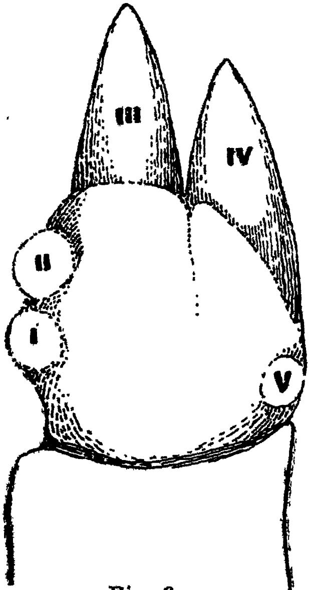

Fig. 3.
Notoryctes typhlops.
Palmar aspect of left manus.

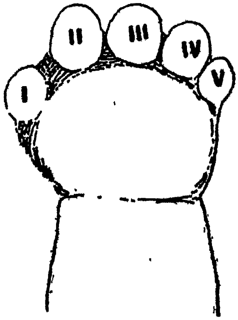

Fig. 4.
Notoryctes typhlops.
Plantar aspect of left pes.

The mouth is elongated and slit-like. The margins of the lips are separated over a considerable portion of their length. There are in the specimen in its present condition no evidences of the adaptation of the mouth to a nipple. The limbs are short and stout, the free portion of the fore limb being considerably longer than the corresponding portion of the hind limb.

The manus and pes are of peculiar interest.

In the manus the enormous, and early, specialization of digits 3 and 4 is remarkable. It is to be noted that, although the digital specialization has proceeded so far, the manus has not undergone the adult folding which makes the determination of the different elements a matter of some little difficulty. It is well known that in his original communication (1891) Sir Edward Stirling designated the specialized digits as 4th and 5th, and assumed that the small digits were the 1st, 2nd, and 3rd. In the extended description published in the same year this error was noted and corrected, and correct figures were published. Despite this, Lucas and Le Souef (1909) speak of "the edge of the large triangular nail of the fifth digit" being used for digging.

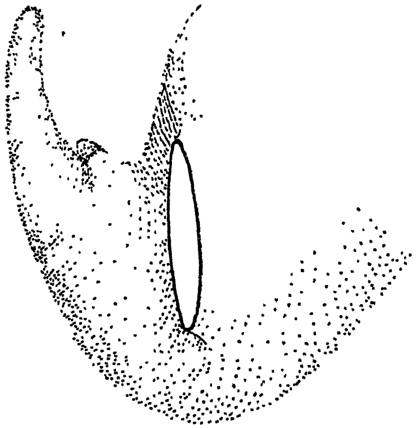

Fig. 5.
Notoryctes typhlops.
Left lateral view of the caudal region.

In the embryo the 1st, 2nd, and 5th digits of the manus are represented by mere tubercles. It is a very remarkable thing that the manus should attain one of its greatest peculiarities by what is essentially an opposition of the 1st and 2nd digits to the 3rd, 4th, and 5th, such as exists, for instance, in *Phascolarctos*.

The pes is short and spade-like, the digits ranged in very primitive fashion, save that the 2nd is very slightly in advance of the 3rd.

The tail, so far, presents none of its adult peculiarities. The external genitalia reveal to external examination only a raised cloacal margin from which protrudes a genital tubercle. No trace of a pouch rudiment, nor of an umbilical site are visible externally.

NOTES ON SOME WESTERN AUSTRALIAN CHITONS (POLYPLACOPHORA), WITH ADDITIONS TO THE FAUNA AND THE DESCRIPTION OF A NEW SPECIES OF *RHYSSOPLAX*.

By Edwin Ashby, F.L.S., M.B.O.U.

[Read May 12, 1921.]

Plate VIII.

Visiting Western Australia in connection with the Congress of the Royal Australian Ornithologists' Union, in October, 1920, I determined to take the opportunity of visiting Ellensbrook, in the south-west corner of that State, during the series of low tides at the end of the month.

Dr. W. G. Torr had done some excellent collecting at that locality at the end of December, 1910, obtaining single examples of two striking and new forms which he described under the names of *Ischnochiton verconis* and *Tonicia hullianus*. It was in the hope of refinding these, and possibly adding further species to the fauna of the State, that we arranged this visit. Unfortunately a heavy westerly gale was blowing during the two days spent at Yallingup, and still heavier seas were coming in during the three days spent at Ellensbrook, entirely precluding any effective work being done at the latter locality.

The work of the two days spent at Yallingup was carried out under great difficulties, and while the number of specimens taken was in consequence very limited, several forms of exceptional interest were secured, and amongst them the second known specimen of Dr. Torr's *Tonicia hullianus*. The rocks are granitic and suited to the habits of chitons

My warmest thanks are also due to my colleague, Mr R. Wilson, of Eden Hills, but for whose able assistance the results would have been much poorer. My stay in that State was prolonged till the next series of low tides, and Geraldton, 306 miles, by rail, north of Perth, and Dongarra, 40 miles to the south of that place, were both visited and the reefs examined for chitons. Unfortunately the rocks in both localities are composed of solid limestone reefs, with rough surfaces, unsuited to the habits of this group of mollusca, consequently very few species were secured, but amongst them, fortunately, were two specimens of a new *Rhyssoplax* which I propose to name *R. Geraldtonensis*, after the locality where it was found.

As a result of the total collecting several species are added to the Western Australian fauna, the range of others greatly extended, and several outstanding problems solved. Altogether nineteen species were collected.

My acknowledgments are due to Dr. Torr for the opportunity of examining his types and the data attached thereto, and to Mr. L. Glauert, of the Western Australian Museum, for the loan of the type of *Lucilina delecta*, Thiele, and other specimens.

Callochiton platessa, Gld.—One small specimen was secured at Yallingup. I have collected this shell in New South Wales, and from there to Western Australia, including Tasmania, and also have specimens from New Zealand, so probably it has the widest range of any of our chitons. The specimen under consideration was adhering to a rock covered with pink calcareous algae; evidently a case of colour protection.

Stenochiton posidonialis, Ashby.—One specimen was taken at Dongarra, living on a stronger form of *Posidonia* than is met with in South Australia. It grew in a fairly sheltered situation inside the reef. The first record of the occurrence of this and the following species in the waters of the Western State is contained in my paper (Jour. and Proc. Roy. Soc. W. Austr., vol. vi., 1920). The present discovery extends its range for nearly 300 miles northwards.

Stenochiton cymodocealis, Ashby.—One specimen was taken on a very fine form of *Cymodocea*, growing in a sheltered situation close to the harbour at Geraldton, thus extending its range for more than 300 miles northwards.

Ischnochiton torri, Ire. and May.—One taken at Yallingup; Torr also recorded it from the same locality.

Ischnochiton virgatus, Reeve.—I found this charming little *Ischnochiton* fairly numerous at Ellensbrook; this is the first published record of its occurrence on the west coast of this State.

Ischnochiton (Haploplax) resplendens, Bed. and Mat.—A nice series of this handsome chiton was obtained on the smooth granitic rocks at Yallingup. Although all were darker in colour than is typical they show the same minute sculpture and highly ornamental markings, consisting of blue spots and varied streaking, that is characteristic of the South Australian shell. They are evidently a larger race, measuring up to 30 × 17 mm.

Ischnochiton (Heterozona) cariosus, Pils.—I found it numerous on the granite rocks at Ellensbrook and Yallingup, and also collected it on the limestone rocks at Rottnest, Dongara, and Geraldton. Heretofore it has not been recorded further north than Rottnest Island. The northern specimens are much lighter in colour than those from Yallingup, the ground-colour of both being pale "Ochraceous-Buff" (Ridgway's Colour Standards, pl. xv.), slightly flecked with darker streaks. The more southern shells are much more extensively thus flecked, which gives them a greyish look. The reddish form so common in South Australian waters is quite absent. The girdle is banded in a varying degree The sculpture differs slightly from the eastern shells, the longitudinal ribbing of the pleural area is less regular, and the nodules of the lateral area are coarser and suggest often two nodulose, radiating ribs. Should it be desired to distinguish this western variety, I suggest that it be known as var *occidentalis*.

Callistochiton meridionalis, Ashby.—This shell was fairly numerous at Yallingup. It was taken by Torr, in 1910, at the same spot, and recorded by him under the name of *C antiquus*, Reeve (Trans. Roy. Soc. S. Austr, xxxv., 1911, p, 98).

Plaxiphora albida, Blain.—I collected these on limestone rocks both at Cottesloe and Dongarra, in positions exposed to the full force of the waves. Dr. Thiele (Faun. Sudwest Austr., III., 1911, p. 402) records the same shell from Cottesloe under the name of *P. albida*, and I saw in the Western Australian Museum a specimen from that locality so labelled by Dr. Thiele. This form is not the heavily wrinkled one that used to be known by Australian collectors as *P. petholata*, Sow., but in most cases it corresponds with the non-wrinkled shell we used to recognize as *P. glauca*, Quoy and Gaim

Dr. Torr (in *loc. cit.*, p. 99) identifies this shell as *P costata*, Blain., and writes as follows:—"Mr. Iredale says, 'Blainville's *costatus* is easily recognizable as the species I have noted as *glauca*, Q. et G.' He agrees with Dr. Thiele, in his Revision des Systems der Chitonen, in placing *P. petholata*, Sow., as *albida* of Blainville, and *P. glauca*, Q. et G., as *costatus*, Blain."

Up to the present I have with some misgivings been following the course adopted by Dr. Torr. I now have a translation of Dr. Thiele's work before me. In it he says, referring to Blainville's type of *Chiton costatus*, which he had before him, that it is "probably the one named *Plaxiphora petholata* by Sowerby (1840); as Blainville's names were published in 1825, *P. costata* is certainly older." He then describes the sculpture as follows.—"The central areas have at both sides a radial rib above which more or less vertical zig-zag striae are visible." He adds that Blainville's shell "is said to have come from King George Sound." He goes on to give the result of his examination of the type of *Chiton albidus*, Blain., "which originated from King Island, south of Australia." His reference to the sculpture is as follows:—"A definite radial rib is not in evidence, only a blunt ridge, having at one place, in the front, a few zig-zag indentations," and adds, "I was unable to examine the original of *Plaxiphora glauca*, Quoy and Gaim., from Tasmania; according to the drawings it would be possible to class it with the last-named species, though the colour is somewhat different." Without going into the question as to how the mistake occurred, it is quite evident that the words quoted from Dr. Torr's paper transpose Dr. Thiele's statement, and the shell that has been referred to by Torr and quoted by Hedley (in Jour. Roy. Soc. W. Austr., vol. i., 1914-15, p. 23) as *P. costata*, Blain., must in future be designated *P. albida*, Blain.

The shells collected by myself at Cottesloe and Dongarra vary considerably; all but one show a single diagonal rib and some are quite free from wrinkling or notching, but others show a slight wrinkling, and one, if held in a certain light, shows distinct raising of the posterior margin of the central valves, suggesting a second diagonal rib so common in the strongly sculptured specimens of *P. petholata*, Sow., which equals *P. costata*, Blain.

The limit of the present paper prevents the discussion being carried further. Either we have been confusing three species and one sub-species under the name of *P. petholata*, Sow., and *P. glauca*, Quoy and Gaim., or these three forms are referable to one very variable species and possibly one sub-species, *viz.*, *P. conspersa*, Ad. and Ang.

Kopionella matthewsi, Ire.—Three specimens of this interesting shell were found at Yallingup. All show similar "oar-headed spicules" to the South Australian form which was fully described in my paper (Trans. Roy. Soc. S. Austr., vol. xliii., 1919), and a like slight cleft in the girdle behind the tail valve.

The writer has now found members of this genus from eastern Tasmania to the west coast of Western Australia, and in every specimen the strange "oar-headed spicules" are present. All specimens I have collected, even when separated by more than a thousand miles, are invariably furnished with these spicules.

No. 1 specimen, measuring 9×6 mm., is similar in method of sculpture to the shells from Marino, in South Australia, and shows the coarsely pustulose radial ribs in the lateral areas, which is so marked a feature in that form

The tail valve, although thickened at its posterior margin, is not as distinctly upturned.

Nos. 2 and 3 are quite distinct in sculpture; they measure, respectively, 14×9 and 13·5×6 mm. The last-named, it will be seen, is long and narrow; quite an unusual form for members of this genus.

The lateral areas in these two are almost smooth, with the exception of the second valve, which in specimen No. 2 gives some evidence of diagonal ribs; in No. 3 a few large nodules are present.

These two specimens suggested affinities with Torr's *Plaxiphora hedleyi*, and so I took the earliest opportunity of visiting the Doctor, who, with his usual kindness, allowed me to make careful examination of his types. I find that the shells I have called 2 and 3 are undoubtedly his species, designated under the name *Plaxiphora hedleyi* (Trans. Roy. Soc. S. Austr., vol. xxxv., 1911, p. 103). I also find that Dr. Torr's *Plaxiphora zebra*, described in the same paper (p. 106) from a single median valve, is similar in sculpture to my specimen No. 1, and corresponds with the South Australian shell known as *K. matthewsi*, Ire. Prior to 1910 Australian collectors used to refer to this shell as *Plaxiphora conspersa*, Ad. and Ang. In June of that year Iredale described it under the name of *P. matthewsi*.

Seeing that Dr. Torr's paper was read in October, 1911, his *P. zebra* becomes a synonym of Iredale's shell. Although it is possible that there is only one very variable species in the waters of South Australia and Western Australia, which the finding of these three shells, above described, in the same hole at the same time, rather supports, I prefer for the present to retain Torr's name as *hedleyi*, as a sub-species of *Kopionella matthewsi*, Ire., and represented by the forms I have herein described as Nos. 2 and 3, with almost smooth lateral areas. The delicate and remarkable "oar-head spicules," which suggested to me the name of the genus, were no doubt removed from Torr's specimen in rough handling in the cleaning.

The tail valve, as shown in Torr's fig. 2E, is a little misleading, the part of that valve behind the mucro is really the thickened edge of the upturned portion; neither is the slight indentation of the girdle behind the mucro indicated in his fig. 2A.

Acanthochiton kimberi, Torr.—I am glad to be able to add this somewhat rare *Acanthochiton* to the fauna of Western Australia. Two specimens in an excellent state of preservation were secured at Yallingup; they show none of the erosion which so often mars the shells of this species. The nearest locality from which this species has heretofore been taken is St. Francis Island, in South Australia, so that the extension of its range to the west coast of Western Australia is very interesting.

Acanthochiton (Notoplax) sub-viridis, Torr.—This interesting shell was described by Torr *(loc. cit.)* from specimens taken by himself at Albany, on the south coast. We have now taken it on the west coast, at Yallingup; the only previous specimens known were those taken by Torr at Albany

Rhyssoplax torrianus, Hed. and Hull.—A nice series were taken at Yallingup, where Dr. Torr also took it in 1910.

Onithochiton scholvieni, Thiele.—This large *Onithochiton* was common on the face of the exposed reef at Dongarra, making it difficult to get with the surf breaking over them; it adhered very tightly to the hollows in the fretted limestone reef. I believe it has not before been recorded further north than the neighbourhood of Perth.

Liolophura georgiana, Quoy and Gaim.—This species was very common on the rocks that were fully exposed at low tide at Ellensbrook, Yallingup, Cottesloe, and Dongarra. The larger specimens were always more or less eroded. Small specimens, on the other hand, are beautifully sculptured.

On examining Torr's type of *Plaxiphora pustulosa*, described from one median valve only *(loc. cit.*, p. 107), the presence of "eyes" in the lateral areas was at once apparent, and suggested its true nature. On comparing it with a well-preserved example of similar age of *L. georgiana*, its identity with it was evident; Torr's example is probably valve No. 5 of that species.

Had Dr. Torr seen the whole shell the mistake, of course, would never have occurred. The accident is not without its compensating features, for I believe no recent first-class figure exists of this shell, so Torr's excellent drawing of the median valve *(loc. cit.*, pl. xxv., fig. 7) under the name *Plaxiphora pustulosa* will always be of use to collectors.

Crytoplax striatus, Lamark.—One specimen only from the east side of Rottnest Island. The only other record of this common eastern species is that given by Dr. Torr, who took it at Hopetoun and Yallingup.

Cryptoplax hartmeyeri, Thiele.—One specimen taken at Yallingup and measuring 12 mm. long was quite new to me. It does not fully agree with Dr. Thiele's figure accompanying his description of the foregoing species (Faun. Sudwest Austr., III., 1911, p. 405, pl. 6, f. 11-17, Shark Bay). The sculpture is more bead-like and the spicules on the girdle are widely spaced and short and thick, quite different from the thickly-set, hair-like spicules of *C. gunni*, Reeve, or the massed, coarse, curved spicules of *C. striatus*, Lamark. As Dr. Thiele's specimen was fully three times the size, the bead-like character may have been somewhat impaired. The examination of more material may alter this determination, but, for the present, I propose to refer the species under review to Dr. Thiele's species.

Tonicia hulliana, Torr.—This very distinct species has heretofore only been represented by the type specimen, a well-preserved adult shell, collected by Dr. Torr, at Ellensbrook, and described by him *(loc. cit.*, p 104, pl. 25, f. 4). It was my fortune to find a single specimen of this hitherto unique chiton, measuring, dry, 6·5 × barely 4 mm. It was quite new to me, being apparently smooth and of a delicate pink colour; a few eyes were then noticed in the lateral areas and end valves, and I, at first, thought it must be referred to Dr. Torr's shell, but on turning up the description and figure I found that the sculptural characters figured and described by him were absent, and that almost the only feature present in mine was quite distinct from his, and concluded that, while it certainly was a *Tonicia*, or rather that division thereof known as *Lucilina*, with posterior mucro, it must be an undescribed form. Later Dr. Torr, with his usual kindness, forwarded me his type of *(Tonicia) Lucilina hulliana*, when I discovered that he had overlooked the juvenile features, which consist of a number of pits in the pleural area immediately abutting on the anterior margin of the lateral areas, high up on the back. The type has about seven of these clearly visible on most of the valves, if held at the right angle of light. Both specimens are carinated, and I think the statement in the description, "Back rounded, side slopes curved," may therefore be a little misleading. The sculpture of the adult form, correctly described by Torr as "concentric growth-lines running from lateral into pleural and dorsal areas," and the "5 or 6 irregular flattened ribs" in the lateral areas, are absent in the juvenile form, although there is a suggestion that these forms of sculpture are about to commence. We have therefore in this species a very excellent example of the wide difference that exists between the sculpture of juvenile chitons and their adult form, a fact I have pointed out in several of my papers. In this case the juvenile method of sculpture is dropped immediately the adult characters begin to appear.

Lucilina delecta, Thiele (Faun. Sudwest Austr., III., 1911, p. 397).—While I did not myself take a specimen of this shell, through the kindness of Mr. L. Glauert, of the Western Australian Museum, I have had the opportunity of comparing specimens "obtained on pearl-shell" from Shark Bay with Dr. Thiele's type, which is in the Western Australian Museum, and I find them the same species. As Dr. Thiele does not figure the shell, I include one in the plate accompanying this paper.

I am indebted to Mr. Nils. H. J. Odhner for a specimen of the shell collected by Dr. E. Mjoberg, of the Swedish Scientific Expedition, 1910-1913, and identified and recorded in Kun. Sve. Vet. Hand. Band. 52, No. 16, p. 12, as *Tonicia truncata*, Sow., from Broome. I find this shell agrees with Dr. Thiele's species. I have been unable to see compared specimens of Sowerby's shell or of Reeves' *T. picta*, now *Lucilina shirleyi*, Ire., but Pilsbry's drawing of this latter shows decided differences between that and Thiele's shell; on the other hand, Pilsbry's drawing of Sowerby's *T. truncata* will fit equally the Broome and the Shark Bay shells—in both the girdle encroaches on the valves, which is said not to be the case in *T. picta*, Reeve.

For the present I am not able to decide the question as to whether Dr. Thiele's *L. delecta* is the same as Sowerby's *T. truncata*, or whether the identification of the shell obtained by Dr. Mjoberg, at Broome, as such, is incorrect; it is quite certain that one or the other name must be withdrawn from our Australian list.

RHYSSOPLAX GERALDTONENSIS, n. sp.

Two specimens, one adult and the other juvenile, were obtained on the reef, Back Beach, Geraldton, November 7, 1920.

General appearance.—Shell strongly carinated, side slopes steep, slightly rounded, lateral areas much raised and bi-ribbed, pleural areas longitudinally grooved, general colour dirty ivory-white mottled with pale brown, polished surface, girdle banded.

Anterior valve.—The apex and nearly half the valve smooth, the rest radially ribbed, which ribs are broken with concentric grooving. I counted eighteen ribs.

Posterior valve.—Mucro slightly posterior and much raised, dorsal area broad and smooth, anterior portion longitudinally ribbed, similarly to the pleural areas in the median valves. Posterior portion of valve margined by a raised, nodulose rib, the portion of valve immediately behind the mucro smooth, posterior portion decorated by radial ribs broken into two or three nodules by deep concentric sulci, the posterior portion of valve slightly recurved.

Median valve.—Dorsal area slightly beaked, broad and smooth, lateral areas much raised, composed of two rather flattened, nodulose ribs separated by a broad groove; in valve 2 there is slight evidence of two of these grooves. Pleural area broken into flat, longitudinal ribs, separated by deep grooves, those next the dorsal area only traversing part of the area. I counted ten of these grooves in some valves.

Girdle.—Clothed with highly-polished, flattish, pebble-like scales, with rounded apices. There is no sign of fluting or ribbing on these scales, but under a high power there is some evidence of parallel scratching.

Measurements.—The dry specimen measures 20 × 11 mm.

Habitat.—On the underside of loose limestones buried deeply in sand, in holes in the solid limestone reef at Geraldton.

Juvenile shell.—Measuring 9 × 5 mm., three longitudinal grooves are present in the pleural area, the nodulose character of the lateral areas is only in evidence in the outer half. A juvenile shell of half this size will therefore have unsculptured pleural and lateral areas, but the latter area will be distinctly raised. The anterior valve is practically without sculpture, with the exception of the very fine decussate pattern that covers the whole shell, probably due to the megalopores.

Comparisons.—While at first sight this shell, with its polished ivory-like appearance, seems very different from *R. tricostalis*, Pils., its method of sculpture approaches that form. The ribs in the pleural area are less raised and further apart than is the case in that species, and suggest weather-boarding rather than the narrow well-raised ribs, separated by deep grooves of *R. tricostalis*. The lateral areas are divided into two ribs, instead of three, and the nodules are more rounded and flatter. The scales, both in shape and lack of grooving, are of a different character. *R. verconis*, Torr and Ashby, which is somewhat kindred in sculpture, has erect, pointed scales, of the same type as *R. jacksonensis*, Ashby. Then, again, the habit of this species in adhering to the underside of limestone rocks buried deeply in sand is very distinct from

R. tricostalis, which loves the exposed sides of clean hard rocks.

In conclusion.—It will be seen by the foregoing that the following must be added to the Western Australian fauna:—*Acanthochiton kimberi*, Torr; *Kopionella matthewsi*, Ire.; and *Rhyssoplax geraldtonensis*, Ashby. That the following must be removed from that list, *viz.*:—*Plaxiphora hedleyi*, Torr, which become a subspecies of *Kopionella matthewsi*, Ire.; *Plaxiphora zebra*, Torr, becomes a synonym of the same species; and *Plaxiphora pustulosa*, Torr, becomes a synonym of *Liolophura georgiana*, Quoy and Gaim. *Plaxiphora costata*, Blain., is replaced by *Plaxiphora albida*, Blain.; *Lucilina delecta*, Thiele, either is replaced by *Tonicia truncata*, Sow., or the record of the occurrence of that shell at Broome, quoted in my paper (Trans. Roy. Soc. S. Austr., vol. xliv., 1920, p. 291), collected by Dr. Mjoberg, must be altered to *Lucilina delecta*, Thiele.

One other correction must be made. Dr. Torr (*loc. cit.*, p. 98) records the occurrence of *Chiton exoptanda*, Bednall, on the strength of "one anterior valve and one median valve, were taken from 20 fathoms in Geographe Bay."

Through the kindness of Dr. Torr I have had the opportunity of examining these valves, and find that the anterior valve has "eyes" and is possibly a worn valve of *Lucilina hulliana*, Torr, and the median valve cannot be identified with *C. exoptanda;* the most that can be said is, that if the characteristic sculptural features of that shell were ever present they have been so worn off as to make determination impossible. The colour approximates very closely to *exoptanda*.

DESCRIPTION OF PLATE VIII.

Fig. 1. *Rhyssoplax geraldtonensis*, Ashby, ×5½.
,, 2*a*. *Tonicia (Lucilina) delecta*, Thiele, posterior valve, ×6.
,, 2*b*. ,, ,, ,, ,, median valve, ×6.
,, 2*c*. ,, ,, ,, ,, anterior valve, ×6.

ON AUSTRALIAN COLEOPTERA OF THE FAMILY MALACODERMIDAE.

By ARTHUR M. LEA, F E.S.

(Contribution from the South Australian Museum.)

[Read June 9, 1921]

The Malacodermidae of Australia were revised by me in 1909,(1) since when comparatively few species have been named; but great attention having recently been paid to the family, and the Blackburn collection containing many novelties, many more species can now be added.

METRIORRHYNCHUS RHIPIDIUS, W. S. Macl.

A specimen, from the Victorian Alps, may represent another variety of this species, its rostrum is long, although rather less than the average length of the species; but its prothorax appears to be five-areolate in an unusual way: from the central areolet three costae connect with the apex (the two side ones are not very distinct from above, but are distinct from the sides), so that there are two small medio-frontal areolets, a fairly large central one, and a very large one on each side; each of the lateral ones has a feeble transverse elevation across part of its middle, but, as it is not in the form of a distinct costa joined to the others, the prothorax cannot be regarded as seven-areolate. In all undoubted specimens of *M. rhipidius* that I have examined the prothorax is distinctly seven-areolate. The specimen may be an individual aberration, of which so many occur in the genus.

METRIORRHYNCHUS FOLIATUS, Macl.

There were two specimens standing in the Macleay Museum as types of this species, and they agree exactly in colour, but only one agrees in structure with the description; it is a male. The other is a female, but certainly not of the same species, its rostrum being much longer and thinner, and prothorax of a very different shape; I have described it as *M. insignicornis.*

METRIORRHYNCHUS SERRATICORNIS, Macl.

Two females, from Cairns, probably belong to this species, but have the hind femora, tibiae and tarsi, middle tibiae, tarsi, and half of the femora blackish, and the scutellum infuscated.

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(1) Lea, Trans. Ent. Soc. Lond., 1909, pp. 45-251.

METRIORRHYNCHUS FUMOSUS, Macl.

Seven specimens, from Cairns, agree with the types of this species, they are opaque-black, to the naked eye (owing to pubescence) appearing a smoky-brown, the antennae are strongly serrated in both sexes, and the scutellum is somewhat narrowed posteriorly, with its end truncated; the length varies from 5 to 9 mm. The female differs from *M. opacus*, of which only a female is known, in the more strongly serrated antennae, prothorax almost parallel-sided and shorter, and in the scutellum, that of *opacus* being emarginate at the apex, with the ends conspicuously produced.

METRIORRHYNCHUS CENTRALIS, Macl.

The types of this species are females; in general appearance they are extremely close to the types of *M. elongatus*, but differ in the central areolet of the prothorax, on *M. centralis* it is terminated fully one-third from the apex of the prothorax, on *elongatus* it extends much nearer to the apex. Two males, from Cairns, that probably belong to *centralis*, differ from the types in being somewhat smaller and narrower, antennae and legs longer, the former more strongly serrated, the prothorax less transverse, and in the abdomen.

METRIORRHYNCHUS GRACILIS, Lea

On this species the front margin of the prothorax is thickened, with a row of punctures almost dividing it into two parallel parts. A second specimen agrees with the type in having the four front areolets of the prothorax ill-defined; but on two males they are sharply defined, their connecting costae being distinct to the hind part of the apical thickening; one of these males has the black tips to the elytra rather larger than on the others, although they are still rather small and oblique.

METRIORRHYNCHUS ATRICORNIS, Lea.

A specimen, from Cairns, probably belongs to this species, but has the scutellum black, and extreme base of elytra flavous; the sides of its prothorax near the base are suddenly incurved, but the angles themselves are much as on the typical form; the difference is probably due to contraction in drying. In my table,(2) owing to the elytra not being entirely dark, it would be associated with *M. ampliatus*, but that species has the pale basal portion larger (distinct to the naked eye), and prothorax with five, instead of three, areolets.

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(2) Lea, Trans. Ent. Soc. Lond., 1909, p. 51.

METRIORRHYNCHUS HETERODOXUS, Lea.

A specimen, from the Dividing Range in Victoria, appears to represent a variety of this species, its elytra have more of the tips red than on the type, but the pale parts of the sides are narrower and terminate before the base, instead of being somewhat dilated on the shoulders, the sides of the prothorax are narrowed in the middle, the true second joint of the antennae is concealed from above, and the third is even shorter than on the type. In the original description by a misprint, the first joint of the antennae was made to read "as long as wide *and* almost concealed", the reading should have been "*2nd* almost concealed."

METRIORRHYNCHUS OCCIDENTALIS, Blackb

M. disconiger, Lea, var.

The type and only specimen of this species known to Blackburn is now in the British Museum, but several specimens, from the Mallee District of Victoria, agree perfectly with the description.

Two males, from Hobart, appear to represent a variety of it, they have the black mark of the elytra at its widest almost extending to the middle of each elytron, and continued from the scutellum to slightly nearer the apex than on the typical form; these specimens agree with the description of *M. disconiger*, consequently the latter name must be regarded as a varietal one only.

METRIORRHYNCHUS EREMITUS, Blackb

Three specimens, from Eden (New South Wales), differ from the typical form of this species in having the pale portion of the elytra confined to the tips, and of the prothorax to the sides.

METRIORRHYNCHUS MELASPIS, Bourg.

This species was described as 8-9 mm in length, with the abdomen (3) and tibiae entirely pale, and the apex of the labrum and the palpi black. There are numerous specimens in the Museum from the Northern Territory (Mary River and Darwin) that appear to belong to the species, but have the labrum entirely pale, and palpi either entirely pale, or partly infuscated; they measure 8-10 mm. in length. The antennae are strongly serrated in the male, with some of the joints subpectinate; in the female they are less strongly serrated.

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(3) By a clerical error in my table the abdomen was noted as "partly" pallid.

Some specimens, from Queensland (Coen River and Cooktown) and North-western Australia (King Sound), are considerably larger (up to 15 mm.), and have the tips of the tibiae, labrum (wholly or in part) and palpi blackish, with the knees infuscated or not.

METRIORRHYNCHUS CANCELLATUS, Lea.

A female of this species, from Gosford (New South Wales), has the antennae much less strongly serrated than in the male, and the third joint of antennae no longer than the fourth.

METRIORRHYNCHUS DIMINUTIVUS, Lea.

Two females, from Cairns, probably belong to this species, they differ from the description in having the dark parts black instead of blackish-brown, the scutellum no paler than the elytra, and the antennae, except the minute second joint, entirely dark.

METRIORRHYNCHUS RAMOSUS, Lea.

Two males, from Mount Tambourine, probably belong to this species, but differ from the type in having the antennal rami shorter, and rather less of the elytra black.

METRIORRHYNCHUS PARVONIGER, n. sp.

♂. Sooty-black.

Head irregularly concave between eyes, muzzle very short. Antennae rather long and feebly serrated, third joint the length of fifth and slightly wider, but at apex no narrower than fourth, slightly longer than the apical width, the others all distinctly longer than wide, after the sixth decreasing in width, and after the eighth in length also, but eleventh slightly longer than tenth. *Prothorax* small, seven-areolate, apical costae sharply defined and rather long, front angles almost rectangular, hind ones acutely produced, sides angularly diminishing to middle. *Scutellum* obtusely bilobed at apex. *Elytra* with single rows of large, transversely-oblong punctures, close to base a few doubled. Length (♂, ♀), 5·5-6 mm.

♀. Differs in having antennae shorter, thinner, and even more feebly serrated, and in the abdomen.

Hab.—Queensland: Cairns district (E. Allen and A. M. Lea). Type, I. 11810.

On each elytron almost throughout there are but five rows of punctures, about the tips they are less angular than elsewhere, and close to the base a few of the punctures in the second and third rows are doubled. The female, taken *in cop.* with the type, has the sides of the prothorax obscurely diluted with red. The variation in colour of the prothorax would distribute the specimens, in my table; the female with it bicolorous would go with *M. coenosus*, which has the elytral margins pale, and the others with *M. insignipennis*, which is a consistently larger Tasmanian species, with somewhat different antennae, and shining elytra. At first glance it resembles *M. fumosus* and *T. ater*, the former has elytral punctures in double series, the latter differs in generic features.

Vars(?) A female, also from Cairns, possibly belongs to this species, but has the third to tenth joints of antennae strongly serrated (subpectinate), its colours are as in the type female, except that each shoulder is obscurely diluted with red. Probably, however, it represents a new species.

METRIORRHYNCHUS MIMICUS, n. sp

♂. Black, tips of elytra brick-red.

Head with muzzle very short. Antennae rather long, third to tenth joints feebly serrated, third to sixth joints about the same width at apex, the others decreasing in width, eleventh about two-thirds the width of tenth, and slightly longer. *Prothorax* conspicuously seven-areolate, strongly narrowed to middle, hind angles produced but tips rounded off *Scutellum* almost truncate at apex. *Elytra* narrow, slightly dilated posteriorly; with single rows of large, quadrangular punctures, becoming double for a short distance at base and about tips. Length, 7 mm.

Hab.—Victoria: Belgrave (F. E. Wilson). Type (unique), I. 12271.

In general appearance strikingly close to the variety *haemorrhoidalis* of *M. rufipennis*, but the elytral punctures in single series (except for a very small part of the base and of the apex); *M. paradoxus* is somewhat larger, with the sides and more of the apex of elytra reddish, the punctures larger, and the interstices not alternately more strongly elevated, as the third and fifth are on this species.

METRIORRHYNCHUS MINUTUS, n. sp.

♀. Black, basal three-fifths of elytra reddish, base and sides of prothorax narrowly and obscurely reddish.

Head with muzzle short. Antennae rather short, wide, and moderately serrated, most of the joints slightly shorter than their greatest width. *Prothorax* small, distinctly seven-areolate, slightly longer than apical width, apex slightly produced in middle, front angles rectangular, hind ones produced, but not very actue. *Elytra* rather thin; with single rows of punctures, except on basal fifth, where they are doubled. Length, 5 mm.

Hab.—Queensland: Port Denison (Aug Simson). Type (unique), I. 11814.

A minute species which, in my table, would be placed with *M. coenosus*, which has tips and sides of elytra pale, and somewhat different antennae; besides the bicoloured prothorax it differs from *M. basalis* in having much smaller elytral punctures, with costae evenly elevated, and antennae somewhat wider.

METRIORRHYNCHUS MARGINICOLLIS, n. sp.

♀. Black, elytra and sides of prothorax brick-red.

Head with muzzle very short. Antennae not very long, moderately wide, third to tenth joints feebly serrated, third distinctly longer than fourth, eleventh scarcely perceptibly longer than tenth. *Prothorax* slightly longer than apical width, conspicuously seven-areolate, sides almost parallel on apical half, then angularly dilated to base, where the angles are acute. *Elytra* thin; with single rows of large, quadrangular punctures. Length, 5·5 mm.

Hab.—Queensland: Mount Tambourine (A. M. Lea) Type (unique), I. 11813.

Rather narrower than *M. uniseriatus*, and antennae very different from those of its female, and the sides of the prothorax pale; the antennae are more like those of *M. minor*, but the elytral punctures and costae are regular to the base, and the sides of the prothorax are pale; it is also close to *M. minutus*, but the elytra are entirely pale, with larger punctures and alternate interstices slightly elevated above the others; in my table would be placed with *M. coenosus*, but the antennae are different, and the elytra entirely pale.

METRIORRHYNCHUS FULIGINEUS, n. sp.

♀. Sooty-black.

Head with very short muzzle. Antennae rather long and moderately wide, third to tenth joints serrated, third longer than fourth, and eleventh longer than tenth. *Prothorax* triareolate; median areolet rather narrow in its middle (where it is widest), and continuous from base to apex, sides strongly elevated and evenly curved, front angles rounded off, hind ones produced and sharply acute. *Elytra* slightly wider near apex than base; with double rows of punctures becoming irregular about tips; alternate interstices distinctly elevated. Length, 6 mm.

Hab.—Queensland: Cairns district (A. M. Lea). Type (unique), I. 11819.

Allied to *M. kingensis*, but with apex of prothorax not notched in middle. I have previously given (4) two short tables of species of Lycides almost identical in colours, but separated by profound structural differences, and one of entirely black species may be of interest·—

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(4) Lea, Trans. Ent. Soc. Lond., 1909, pp. 62, 63.

Prothorax not divided into conspicuous areolets ... ... *D. melancholica*, Lea
Prothorax with conspicuous areolets.
Subsutural costa trifurcate near base ... ... *T. ater*, Macl.
Subsutural costa simple.
Elytral punctures in single series.
Elytra opaque ... ... *M. parvoniger*. Lea
Elytra shining ... ... *M. insignipennis*, Blackb.
Elytral punctures in double series.
Prothorax three-areolate.
Apex of prothorax deeply notched in middle ... ... *M. kingensis*, Lea
Apex not notched ... .. *M. fuligineus*, Lea
Prothorax seven-areolate.
Antennae of male ramose . *M. funestus*,(5) Lea
Antennae of male not ramose ... ... *M. rufipennis*, Fab., var.

METRIORRHYNCHUS INSIGNICORNIS, n. sp.

♂. Black; prothorax (except for a large blackish discal blotch) and elytra brick-red.

Head with rostrum unusually long and thin. Antennae long, the first six joints with long and fairly dense hairs on the under-surface, first joint small, second minute, third long and thin (about four times as long as wide), fourth about two-thirds the length of third, and slightly longer than fifth, the latter feebly produced on one side at apex, sixth the length of fifth but strongly produced at apex, seventh to tenth shorter and pectinate, eleventh thin. *Prothorax* moderately transverse, seven-areolate, apex produced in middle, sides incurved to middle, base trisinuate, the hind angles moderately acute *Scutellum* with two rather acute tips. *Elytra* thin and parallel-sided, with regular double rows of punctures, the alternate interstices elevated. Subapical segment of *abdomen* notched in middle almost to base. Front and middle *trochanters* each with an acute spine, hind pair largely produced and truncated; front femora flat and unarmed, middle femora with a small tooth at basal third; hind pair much stouter than the others, obtusely dentate about middle, largely excavated on one side of base, and clothed on under-surface with long hairs as on antennae; hind tibiae thicker than the others, and with hairs as on femora. Length (♂, ♀), 9-10 mm

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(5) An allied species (probably undescribed) occurs in the Madang district of New Guinea.

♀. Differs in having antennae shorter, without long hairs, the joints after the fifth serrated but not pectinated, legs unarmed, hind femora no stouter than the others, and without special clothing, and abdomen not notched.

Hab.—Queensland: Gordonvale (Dr. J. F. Illingworth), Cairns (Macleay Museum). Type, I. 11820.

At first glance strikingly close to *M. lateralis* and similarly coloured species, but the remarkable antennae and legs readily distinguish the male from all previously named males of the genus. One of the females was placed with the type of *M. foliatus* in the Macleay Museum, but it is certainly not that species, from which it differs in having the rostrum much longer, and sides and apex of prothorax very different. The rostrum is distinctly longer than the prothorax in both sexes; the black of the prothorax touches the base, except in middle, but not the sides or apex.

METRIORRHYNCHUS PALLIDOMINOR, n. sp.

♂. Flavous; tips of elytra, six apical joints of antennae and parts of two preceding ones, palpi and tarsi (except claw-joint) black or infuscated.

Head with rostrum of moderate length. Antennae rather long, third to tenth joints oblong, third about one half longer than fourth, eleventh one half longer than tenth. *Prothorax* slightly longer than wide; conspicuously seven-areolate; apex obtusely produced in middle, sides gently incurved to middle, hind angles slightly rounded, the front ones strongly. *Elytra* thin and parallel-sided; with regular double rows of punctures, alternate interstices slightly elevated. Length (♂, ♀), 5-6 mm.

♀. Differs in having somewhat shorter antennae and wider abdomen, with the subapical segment not notched.

Hab.—Northern Territory: thirty miles east of Darwin (G. F. Hill). Type, I. 12265.

A small, thin, pale species, not very close to any other known to me; the blackish tips to the elytra are about one-eighth of their length; the antennae might fairly be regarded as nonserrated; the frontal areolets of the prothorax are longer than usual. The length of the rostrum (including the mandibles) is somewhat less than the basal width, and not half the length of the prothorax; regarding it as of moderate length, in my table it would be placed with *M. rufirostris;* regarding it as short, with *M. fallax;* each of which species is considerably larger, with black under-surface and legs.

METRIORRHYNCHUS FUNESTUS, n. sp.

♂. Sooty-black.

Head with very short rostrum. Antennae rather long, third to tenth joints ramose, eleventh more than twice the length of the non-ramose portion of tenth. *Prothorax* moderately transverse; conspicuously seven-areolate; front angles slightly obtuse, hind ones produced and acute, sides almost parallel to near base *Elytra* parallel-sided; with somewhat irregular double rows of punctures, the alternate interstices distinctly elevated. Length, 5·5-6·5 mm.

Hab.—Queensland: Cairns district (A. M. Lea). Type, I. 11825.

Readily distinguished from all previously named black species by the long antennal rami; *M. opacus*, of which only the female is known, has very different prothorax; the ramus of the third joint commences near the middle of the inner side, on the others it is gradually advanced till on the tenth it commences near the tip, on the third and tenth joints it is almost twice the length of the supporting portion, on each of the intervening joints it is more than twice the length of its supporting portion. Of the median areolets of the prothorax the front ones are about two-thirds the length of the hind one. The short costae dividing off the elytral punctures are often transversely Y-shaped, and from some directions the rows in places appear to be in single instead of double series; but when the elytra are so placed that the thinner parts appear semitransparent, the punctures appear to be in quite regular double rows.

METRIORRHYNCHUS RUFOMARGINATUS, n. sp.

♂. Black; tips of elytra, each lateral costa, and part of suture bright red.

Head with rostrum very short. Antennae moderately long, third to tenth joints strongly serrated or subpectinated. *Prothorax* moderately transverse, apex obtusely produced in middle, sides moderately dilated and rather strongly elevated from middle to base, front angles obtuse, hind ones (except for a slight rounding off) almost square; conspicuously seven-areolate, the median areolet produced in front to about the middle of the medio-frontal areolets. Tips of *scutellum* produced. *Elytra* slightly dilated posteriorly; with irregular double series of large punctures, alternate interstices slightly elevated. Length (♂, ♀), 13-17 mm.

♀. Differs in having the antennae shorter and less strongly serrated (not subpectinated), abdomen wider, the subapical segment not notched, and legs slightly shorter.

Hab.—Victoria: Lorne (F. E. Wilson). Type, I. 12273.

The red tips to the elytra extend for from three to seven punctures in length; on the male the suture is red for almost half its length, on the female for scarcely one-fourth; on the male the middle of the apex of the prothorax is slightly notched, on the female more conspicuously so, but the character is probably not dependable. In my table would be placed with *M. rufipennis*, and in fact the types look like large specimens of the variety *goryi* of that species, but they differ in having the prothorax more transverse, its sides more feebly incurved about middle, the antennal serrations different, and the tibiae thinner.

METRIORRHYNCHUS MODICUS, n. sp.

♂. Black; sides of prothorax and tips of elytra flavous.

Head with rostrum short (distinctly wider than long). Antennae moderately long, third to tenth joints strongly serrated. *Prothorax* moderately transverse; conspicuously seven-areolate, apex produced in middle, sides strongly elevated, especially behind middle; front and hind angles rounded off. *Elytra* slightly dilated posteriorly; with double rows of irregular punctures; alternate interstices moderately elevated. Length (♂, ♀), 8-10·5 mm.

♀. Differs in having somewhat shorter and less strongly serrated antennae, and subapical segment of abdomen not notched.

Hab.—New South Wales: Eden, in October (Dr. E. W. Ferguson and H. J. Carter). Type, I. 12274.

In some respects close to *M. eremitus*, with which it would be associated in my table, but elytra more dilated posteriorly, and with only about one-sixth pale at the tips; the pale portion, however, is slightly advanced on the sutural and lateral costae, the prothorax also is pale only on the sides.

METRIORRHYNCHUS COMPOSITUS, n. sp.

♂. Black; prothorax, scutellum, and three-fifths of base of elytra of a rather dingy flavous.

Head with rostrum very short. Antennae moderately long, acutely serrated. *Prothorax* along middle (owing to the obtusely produced apex) almost as long as wide, conspicuously seven-areolate, front angles obtuse, hind ones produced and acute, median areolet produced to beyond middle of medio-apical ones, these much smaller than latero-apical ones. *Elytra* thin and parallel-sided; with regular double rows of punctures, except about tips, the alternate interstices distinctly elevated. Length, 8·5 mm.

Hab.—Queensland: Coen River (H. J. Carter from H. Hacker). Type (unique) I. 11850.

On the type there is an infuscated stain at the inner corner of each of the latero-basal areolets, and the scutellum is also infuscated towards the base. In my table would be placed with *M. posticalis*, but the frontal areolets are very different, and the antennae are non-ramose; regarding the dark parts of the prothorax as more than stains it would be placed with *M. marginipennis* and *M. eremitus*, whose pale elytral markings are longitudinal.

METRIORRHYNCHUS CRASSIPES, n. sp.

♂. Black and flavous.

Head with very short rostrum. Antennae rather short and wide, third joint distinctly longer than fourth, and each feebly serrated, the others to tenth more strongly serrated and gradually decreasing in width, eleventh about one-half longer than tenth. *Prothorax* moderately transverse; conspicuously seven-areolate; apex obtusely produced in middle, sides narrowed to middle, front angles obtusely rounded, hind ones slightly rounded. *Elytra* rather thin; with double rows of somewhat irregular punctures, alternate interstices distinctly elevated. *Legs* rather stouter than usual. Length, 7-7·5 mm.

Hab.—North-western Australia: Forrest River, in February (J. Clark from W. Crawshaw); Northern Territory: Stapleton, in February (G. F. Hill, No. 54). Type, I. 11832.

The flavous parts are the prothorax, scutellum, elytra (except for rather more than the apical fourth), abdomen (three or four of the basal segments deeply infuscated or black), coxae and base of femora (more of the middle than of the hind ones, and less than of the front ones). In my table would be placed with *M. posticalis*, but the male of that species has flabellate antennae; in appearance the type is somewhat like a small specimen of *M. apicalis*, *M. abdominalis*, or *M. melaspis*, but its rostrum is short; many species of *Trichalus* are similarly coloured.

Var. (?) Another male, from the Forrest River, may belong to this species, but it differs from the others in having the prothorax with the sides almost parallel, its front margin semidouble (approaching that of *M. gracilis*), more than one-third of the elytra black on the sides, but the flavous part triangularly advanced at the suture, more of the hind femora pale, and the abdomen entirely black.

METRIORRHYNCHUS EUCERUS, n. sp.

♂. Flavous, head (partly or entirely), antennae (basal joints sometimes obscurely paler), palpi and apical fourth or fifth of elytra black, tarsi and metasternum more or less deeply infuscated.

Head with very short rostrum Antennae with long rami. *Prothorax* moderately transverse; conspicuously seven-areolate; apex obtusely produced in middle, sides narrowed to middle, front angles obtuse, hind ones produced and acute, median areolet large, produced fairly close to apex. *Elytra* rather thin and parallel-sided; with double rows of regular punctures to near apex, the alternate interstices moderately elevated, but the same as the others on the dark portion. Length, 7-9 mm.

Hab.—Northern Territory: Darwin and Daly River (H. Wesselman). Type, I. 11828.

The ramus on the third joint of the antennae is about twice the length of its supporting portion, on the following ones, to tenth, it is longer (up to thrice the length of its support), the eleventh joint is about thrice the length of the non-ramose portion of the tenth; the lengths of the rami, however, vary slightly on the six specimens taken. In my table the species would be placed with *M. posticalis*, *M. gracilis*, and *M. fallax*: of these *gracilis* was described as having more of the under-surface and legs dark, and less of the elytra, and with very different prothoracic areolets, on the present species they are all well defined, and the central one is not confined to the basal half; *posticalis* has more of elytra and of under-surface dark, and the areolets different; *fallax* (of which I only know the females) has less of elytra and more of under-surface dark, and the areolets different

METRIORRHYNCHUS TRICHOCERUS, n. sp.

♂. Flavous; head, antennae, palpi, apical third (or more) of elytra, abdomen, tarsi, and parts of tibiae black.

Head with rostrum very short. Antennae with long rami on third to tenth joints, the rami with moderately dense and rather long hairs, eleventh joint more than twice the length of the non-ramose part of tenth. *Prothorax* moderately transverse; conspicuously seven-areolate, apex obtusely produced, sides narrowed to middle; front angles obtuse, hind ones slightly produced and subacute, central areolet slightly produced between bases of medio-apical ones. *Elytra* thin and parallel-sided; with regular double rows of punctures, the alternate interstices moderately elevated. Length, 6-7·5 mm.

Hab.—Northern Territory: Melville Island (W. D. Dodd). Type, I. 11820.

All the rami are long, the shortest (on the third joint) being almost twice as long as its support. The species is allied to the preceding one, but the rami have conspicuous clothing, the abdomen is dark, and the metasternum pale (there are six of the preceding species and three of the present before me, and the differences noted are constant); in my table would be placed with *M. posticalis*, which has darker legs and under-surface, median areolet of prothorax longer, etc.

A female, from Stapleton (G. F. Hill), probably belongs to this species, its colours are as in the type, except that the basal joint of the antennae is obscurely pale (as it is also on one of the males); its antennae are shorter, rather wide, and the fourth to tenth joints are moderately serrated, the eleventh joint is almost twice the length of the tenth, the abdomen is wider, its subapical segment is not notched and the legs are shorter.

TRICHALUS INFAUSTUS, n. sp.

♂. Sooty-black; prothorax, and rather more than basal half of elytra of a dingy flavous.

Antennae moderately long, third to tenth joints strongly serrated. *Prothorax* slightly longer than apical width, sides considerably elevated near base, and somewhat sinuous, front angles rounded off, hind ones acute, central areolet continued to apical fifth and connected with apex by a short costa. *Elytra* rather thin, slightly narrowed in middle, subsutural costa trifurcate at basal fourth. Length, 9·5-10·5 mm.

Hab.—Queensland: Cairns district (A. M. Lea), Atherton (Dr. E. Mjoberg). Type, I. 12277.

In my table⁽⁶⁾ would be placed with *T. flavopictus*, which is a larger species, with wider prothorax, elytra more dilated posteriorly, and less of apex dark; the dark part is not sharply limited, but is continued almost to the middle as an infuscation; on both specimens before me there is an infuscated stain on the disc of the prothorax, and the scutellum is dark.

TRICHALUS QUADRICAVUS, n. sp.

♀. Black; prothorax, scutellum, basal four-fifths of elytra, front and middle coxae, and trochanters flavous.

Antennae rather long, third joint about twice as long as its apical width, and slightly longer than fourth, the others to tenth slightly decreasing in length and width but none transverse, eleventh about half as long again as tenth. *Prothorax* about as long as the apical width, front angles obtuse, hind ones acute; central areolet divided into two parts. *Elytra* parallel-sided to near apex, alternate interstices distinctly elevated, the subsutural one trifurcate at basal third. Length, 8 mm.

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(6) Lea, Trans. Ent. Soc. Lond., 1909, p. 90.

Hab.—Queensland: Cairns district (A. M. Lea). Type (unique), I. 11839.

One side of the prothorax of the type is gently incurved to the middle, but the other is slightly dilated there, this appears to be due to post-mortem contractions. The dark part of the elytra is slightly dilated on the sides. At first glance the type appears to be a specimen of *T. froggatti*, with more of the apex of elytra black than usual; but the doubling of the central areolet associates it with *T. insignis*, which is a much larger species, with part of the prothorax black, and the black markings of elytra longitudinal instead of apical; the basal portion of the central areolet is half the length of the segment, then there is a portion half its size, and a carina connects this with the apex.

DUMBRELLIA PILOSICORNIS, Lea.

Two males, from Melville Island, appear to belong to this species, but differ from the type in having more of the apex of the elytra black: on one specimen occupying about one-fourth of the elytra, on the other less about the suture, but as much near the sides; the prosternum and mesosternum are flavous, and the head is moderately infuscated instead of black; on one of them the head is flat between the eyes, on the other there is a depression there, although not as deep as on the type; the differences are probably due to contractions on drying.

DUMBRELLIA MELANCHOLICA, n. sp.

♀. Sooty-black; head and prothorax somewhat shining.

Head with a rather feeble median line, but ending in front in a small, deep fovea. Antennae rather long and thin, most of the joints cylindrical, second very small, third wider than fourth, but somewhat shorter, the following ones to tenth feebly decreasing in width, eleventh slightly longer than tenth. *Prothorax* about twice as wide as long, apex gently produced in middle, sides feebly increasing in width to base, front angles obtuse, hind ones produced and acute, a narrow deep transverse impression on each side of base, but isolated from a small medio-basal impression; with rather large submarginal punctures at sides and apex. *Elytra* thin and parallel-sided; with almost regular rows of rather large, rounded punctures. Length, 5·25 mm.

Hab.—Queensland: Cairns district (A. M. Lea). Type (unique), I. 11843.

Readily distinguished from the two previously described species by its entirely dark upper-surface; the deep median line of the prothorax of these species is represented on the present one by a basal fovea only.

CALOCHROMUS GUERINI, Macl.

Two specimens, from Cairns, differ from the typical form of this species in having the prothorax red, except for a narrow dark median line; another, from Dorrigo, has the prothorax normally coloured, but the elytra entirely red.

CALOCHROMUS INSIDIATOR, Fairm.

A male, from the Tasmanian Lakes, and three others, from Ulverstone, have a blackish triangle about the scutellum, and so, at first glance, appear to belong to *C. scutellaris*, but the head is unarmed.

CALOCHROMUS AMABILIS, Lea.

Three males, without exact locality labels, from the Blackburn collection, probably belong to this species; they have the punctures about the tips of the elytra decidedly coarser than elsewhere, and similarly thick antennae to those of the types, the apical marking, however, is briefly transversely-elliptic, instead of slightly advanced along the suture, and concave between the suture and each side. The antennae are decidedly shorter and thicker than those of the male of *C. basalis*, but the elytral interstices are intermediate between those of that species and *amabilis*.

CALOCHROMUS DENTICULATUS, n. sp.

♂. Blackish-purple; prothorax, scutellum, and elytra (except apical sixth) lemon-yellow.

Head with a flange-like process overhanging and concealing labrum; a narrow median line at base, ending between antennae in a small, deep fovea. Antennae long and thin, first joint stout, second very small, third wider and shorter than fourth, the others to tenth subequal in length, and very feebly decreasing in width, eleventh slightly longer than tenth. *Prothorax* almost twice as wide as long, a large sinuous depression near each side, and a narrow one along middle. *Elytra* almost parallel-sided; punctate-striate, punctures partially concealed by pubescence, but becoming more distinct about apex, where the striae vanish; alternate interstices somewhat elevated above their fellows. Front *femora* rather stout; with two rows (two or three in each row) of small teeth, or acute granules, on under-surface near apex; front tibiae denticulate on lower-surface. Length, 12 mm.

Hab.—Queensland: Coen River (W. D Dodd). Type, I. 11840.

The head has a curious process that projects in front so that the labrum is concealed from above, its front angles are rectangular, but the middle is slightly produced, from the sides it resembles a thin flange, it is not an acute process such as in *C. scutellaris*, so I regard the head as unarmed, and so regarding it the species would be associated with *C. guerini*, in which the process is ridged along the middle in the male; the antennae are slightly longer (13 mm.) than the body. It belongs to Waterhouse's second section of the genus.

A specimen from New South Wales (Wentworth Falls, H. J. Carter), possibly belongs to this species, but has the dark part of the elytra advanced to the basal fourth, the front femora with more numerous teeth (seven on one of the rows), and the dentition of the front tibiae inconspicuous. Another specimen, from the Madang district of New Guinea, possibly also belongs to the species, but the dark part of the elytra has a deep metallic-green gloss, and leaves only the basal fifth pale, the denticulation of its front legs is as on the Wentworth Falls specimen.

LUCIOLA COWLEYI, Blackb.

Some years ago I received from the late Rev. T. Blackburn a specimen bearing his name—label "*Luciola cowleyi*, Blackb.," but without a locality label; this specimen agrees well with the description, except that parts of two abdominal segments are white; whereas in the description only the penultimate segment was noted as white; on some specimens with the apical segment contracted, however, its white part is scarcely distinct from that of the preceding segment, so that possibly he was misled, or the type may have been a female (unknown to me) with really only one segment white. There are numerous males in the Museum, from the Northern Territory, that agree with the specimen above noted, and all of them have the white of the abdomen confined to the lower-surface; the dark parts of the elytra vary somewhat in intensity of colour, and on some specimens only a small part of the base of each could be regarded as blackish.

LUCIOLA FLAVICOLLIS, Macl.

A specimen, from Normanton, possibly represents a variety of this species; it is larger (6·5 mm.) than usual, and the suture is as widely pale as the sides, but the black covers the whole of the tips; three apical segments of the abdomen are pale, but the two apical ones are more flavous than the other, which is almost white, the apex of the subapical segment is gently but distinctly incurved to the middle, much as in females of *L. humilis*, and *A. lychnus*, but less strongly than in the females of *L. platygaster*, and *L. complicata*, and the femora are entirely pale. The apex of its prothorax is feebly produced as on females of other species, and the head is only feebly concave. On normal specimens of *flavicollis* the third segment from the apex of the abdomen is entirely white on both sexes, the two apical ones are dark on the female, and the subapical one has a large, white, medio-basal patch on the male.

LUCIOLA DEJEANI, Gemm.

L. apicalis, Boi., n. pr.

♂. Flavous; head, antennae, palpi, a spot at apex of each elytron, part of third segment of abdomen, tarsi, and tips of tibiae, black or infuscated; two apical segments of abdomen white.

Head concave, shining, and with small punctures between eyes. Antennae with third joint slightly longer than fourth. *Prothorax* about twice as wide as long, depressed near margins, median line distinct; punctures dense. *Elytra* subparallel-sided to near apex, with feeble remnants of discal costae, punctures small and crowded, but sharply defined. Length, 8 mm.

Hab.—Probably Northern Territory.

The abdomen appears to be composed of two pale segments, then an infuscated one, then a white one similar in shape to the third, then a long white one with its tip rounded (it is possible, however, that there is a very small white one, inconspicuously attached to the tip of the fifth, and obscured by pubescence).

There are before me two species, either of which may be *dejeani* (or possibly neither), the original description is "Lutea, capite nigro; elytris apice nigris; subtus lutea." With a translation into French. The locality was New Holland. But of these two species the one described above (without locality label but probably from Darwin) bears Blackburn's name-label "Luciola dejeani Gemming," and as less of its under-surface is dark than on the other (described below) I shall presume that it is correctly identified (7); it is somewhat smaller and narrower than the specimen in the Australian Museum identified by Olliff as *dejeani*, but appears to belong to the same species.

LUCIOLA COSTATA, n. sp.

♂. Flavous; head, antennae, palpi, about one-fourth of apex of elytra (less on suture and sides), two segments of

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(7) The type is probably in the Paris Museum.

abdomen, tarsi and tibiae (except at base), black or blackish; two apical segments of abdomen white.

Head concave and with dense punctures. Antennae with third joint slightly longer than fourth. *Prothorax* about twice as wide as long, with irregular submarginal depressions, median line distinct; punctures of moderate size, crowded, and somewhat asperate. *Elytra* rather wide, subparallel-sided to near apex; each with four discal costae, of which the inner two are conspicuous, commence at the base and terminate on the black portion, the other two are feeble, commence at the basal third, and terminate just inside the black portion; punctures dense and sharply defined, but rather small. Length, 8·5-9 mm.

Hab.—Northern Territory: Flora River (Prof. Baldwin Spencer). Type, in National Museum; cotype, I. 12280, in South Australian Museum.

Of the abdominal segments the first is scarcely darker than the sterna, the second is deeply infuscated, third black, fourth white and slightly shorter than third, fifth white and almost thrice as long as fourth, owing to an obtuse extension of its apex. On the type the apex of the prothorax is produced in the form of a distinct (although very wide) triangle, on a second specimen it is scarcely produced there; the difference is probably due to post-mortem contractions. This species can hardly be the one identified by Olliff as probably *L. dejeani*, as each elytron has four discal costae of which the inner two are very distinct (quite as distinct as the sutural thickening), the tibiae are pale only at the base, and two of the abdominal segments are dark, whereas on the preceding species (assumed to be *dejeani*), the discal costae are all very feeble, tibiae dark only at apex, and only one segment of abdomen dark.

LUCIOLA COMPLICATA, n. sp.

♂. Blackish; prothorax, scutellum, suture for a short distance near base, sterna, abdomen (except for two white segments), and legs (tarsi, front and middle tibiae infuscated) flavous.

Head concave, shining, and with minute punctures. Antennae with third joint produced on one side, and distinctly shorter than fourth. *Prothorax* almost twice as wide as long, depressed near margins, median line sharply defined; with fairly dense and sharply defined punctures. *Elytra* parallel-sided to near apex, with vague remnants of discal costae; punctures crowded and rather small, but sharply defined. Hind *femora* stouter than the others and somewhat curved; hind tibiae curved at base and stouter than the others. Length (♂, ♀), 5·5-7 mm.

♀. Differs in having smaller and less concave head, eyes smaller, third joint of antennae scarcely shorter than fourth and of the same shape, hind legs thinner and less curved, and in the abdomen.

Hab.—Queensland: Coen River (W. D. Dodd). Type, I. 11844.

On two males the basal segments of abdomen are small and shrivelled, the two following ones are large and entirely white, the second of these has its tip sinuous and a flavous subconical process on each side, beyond this the segments are depressed, with ,a large circular cavity on each side, bounded posteriorly by a shining ring-like elevation; the tip is deeply notched, with a small conical lobe (probably the tip of the sixth or seventh segment) in the notch; on the female only one segment is white, the next one is flavous, and rather widely incurved to the middle of the apex, with the following segment moderately long and also flavous. It is allied to *L. platygaster*, but the male with curious circles below the second phosphorescent segment, and this with conical processes at the sides; the male is distinguished from the female of that species by its pale legs.

ATYPHELLA FLAMMANS, Oll.

A male, from Kuranda, differs from the typical form in having the dark parts of each elytron reduced to a medio-basal patch between the first and third discal costae, and a still smaller apical one.

TELEPHORUS PULCHELLUS, W. S. Macl.

Mr. H. J. Carter and I saw a dwarf form of this species in abundance on flowers on Cradle Mountain, and Mr. L. Rodway took similar specimens on the summit of Ben Lomond in Tasmania.

TELEPHORUS VIRIDIPENNIS, Macl.

Many specimens of this species have the prothorax immaculate, on others there is a spot varying from hardly more than a small infuscated stain to large, sharply defined and black, with a greenish gloss.

TELEPHORUS RUFIVENTRIS, Macl.

T. tepperi, Blackb.

The type and a co-type of *T. tepperi* are but slight varieties of *T. rufiventris*, and similarly coloured specimens occur in Queensland.

TELEPHORUS GRACILIPICTUS, Lea.

The female of this species differs from the male in having the head narrower across the eyes, less of the muzzle flavous, and the antennae and legs shorter.

TELEPHORUS APICICOLLIS, n. sp.

♂. Flavous, most of elytra and of abdomen black or infuscated. Rather densely clothed with short, ashen pubescence.

Head rather wide and flat, clypeus notched in middle; with very minute punctures, dense in places. Eyes rather large. Antennae long and thin, third joint slightly shorter and wider than fourth. *Prothorax* distinctly longer than wide, apex produced in an even curve over prothorax, and with distinct asperate punctures, elsewhere with very minute punctures; a large depression on each side near apex, and a shallow one in middle of base. *Elytra* long, thin, and almost parallel-sided; with dense and minute punctures, interspersed with numerous larger (but still small) asperate ones, sparser about base than elsewhere; with very feeble remnants of discal costae. Apical segment of *abdomen* deeply notched. *Legs* long and rather thin. Length, 8·5-9 mm.

Hab.—Northern Territory: Melville Island (W. D. Dodd and G. F. Hill), Bathurst Island (Hill). Type, I. 11855.

Allied to *T. macrops*,⁽⁸⁾ but prothorax decidedly longer, and elytra, except for a small basal portion, deeply infuscated or black; in my table⁽⁹⁾ it would be associated with *T. immaturus*, and *T. nigroterminalis*, to which, however, it is not very close. The produced part of the prothorax has a thin apical fringe, but it appears to be easily abraded. The flavous portion of the elytra is from about half to three-fourths the length of the prothorax; on the type it is narrowly continued along the sides and suture for a short distance; on a second specimen it is very narrowly continued almost to the apex; on a third specimen it is sharply limited near the base; the infuscation of the abdomen is less pronounced than that of the elytra.

SELENURUS ANNULATUS, Macl.

There are two forms of this species before me. On the first and evidently the typical one (as the flavous portion extends backwards along the suture, on several specimens in

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(8) In the original description two figures (157 and 173) were quoted for this species in error.

(9) Lea, Trans. Ent. Soc. Lond., 1909, p. 113.

fact narrowly connected with the apex) the black basal marking on the elytra is completely isolated, as the flavous subbasal part is continued to the extreme margins. On the second form the subbasal flavous part is larger, but is not continued along the suture, and does not touch the sides near the base, although from above it appears to do so.

SELENURUS TENUIS, n. sp.

♂. Black; elytra with an obscure bluish or greenish gloss, prothorax flavous, with a small discal infuscation, parts of muzzle and tips of abdominal segments obscurely flavous. Clothed with short, ashen pubescence, and some longer, dark hairs.

Head rather elongate. Antennae moderately long and thin, third joint about half the length of the fourth. *Prothorax* subcylindrical, distinctly longer than wide, surface slightly uneven. *Elytra* slightly wider than prothorax, narrowed posteriorly, terminated long before apex of abdomen; granulate punctate, or with coarsely rugose punctures. *Legs* long and thin. Length (♂, ♀), 5-6 mm.

♀. Differs in having somewhat smaller head and shorter legs.

Hab.—South Australia: Lucindale (F. Secker). Type, I. 11853.

Allied to *S. sydneyanus*, but prothorax decidedly longer, elytra shorter and more coarsely sculptured, and antennae thicker; the prothorax is much the shape of that of *Telephorus kershawi*, but that species is without flight wings, whereas on this species they are present. The discal spot is at about the apical third and occupies about one-fourth the length of the prothorax, on one of the males, and on the two females before me; on a second male it is represented by two minute dots. The abdomen is badly shrivelled on all of them.

SELENURUS TENUICORNIS, n. sp.

♂. Black; elytra with an obscure olive-green gloss; part of muzzle, prothorax (except for a large discal blotch), scutellum, much of sterna, tips of most of the abdominal segments, coxae, basal half of femora, and base of tibiae flavous. With short, ashen pubescence.

Head rather wide; with large prominent eyes; sides thence strongly narrowed to base; with minute punctures. Antennae long and thin, third joint about half the length of fourth. *Prothorax* longer than wide, sides almost parallel, apex obtusely produced in middle, disc uneven. *Elytra* much wider than prothorax, much shorter than abdomen, strongly narrowed posteriorly, with a feeble and rather short discal costa on each; with dense and minute, rugulose punctures or shagreened. *Legs* long and thin. Length (♂, ♀), 6-9 mm.

♀. Differs in having somewhat smaller, but still very prominent eyes, and somewhat shorter antennae and legs.

Hab.—Queensland: Coen River (W. D. Dodd). Type, I. 12253.

Close to *S. sydneyanus*, but larger, antennae longer, elytra much less coarsely shagreened, scutellum flavous (instead of black), more of the legs flavous, and prothoracic blotch of different shape; the blotch is of irregular shape, slightly dilated in front and behind, and narrowly touches each side about the middle. The under-surface of several of the basal joints of antennae are obscurely pale. The types are fastened together, as they were taken *in cop.*, and their abdomens are greatly shrivelled.

SELENURUS FLAVOINCLUSUS, n. sp.

♂. Black and flavous. Densely clothed with short pubescence, varying in colour with the derm.

Head rather wide across eyes, strongly narrowed to base; with dense and minute punctures. Antennae long and thin, third joint about half the length of fourth. *Prothorax* considerably longer than wide, disc uneven, sides and suture thickened, apex produced over base of head; punctures very minute. *Elytra* much wider than prothorax, long, thin, and regularly decreasing in width posteriorly, with tips diverging from suture; with dense and fine rugulose punctures or shagreened. Subapical segment of *abdomen* semicircularly incised. *Legs* long and thin. Length, 10-13 mm.

Hab.—Queensland: Cairns district (E. Allen and F. P. Dodd). Type, I. 11852.

The pale parts are portion of the muzzle, prothorax, scutellum, elytra (base suture and sides narrowly black, but tips entirely pale), parts of sterna, tips of abdominal segments, basal half of femora, and extreme base of tibiae. The pale tips of the elytra associate the species with *S. annulatus*, from which it differs in being larger, elytra longer, with the flavous portion of each considerably longer, only just interrupted before the apex, instead of separated from the tips by a wide black band, the suture also is dark from the base to just before the tips, so that the flavous portion is separately enclosed on each elytron; on *annulatus* the larger flavous portion is continuous across the suture;

more of the legs are dark and the prothorax is immaculate. On two of the specimens the abdominal notch is double, but this appears to be due to post-mortem contraction.

HETEROMASTIX.

The species of this genus usually have the elytra black, prothorax flavous, and head, legs, and antennae varying from partly to entirely black or flavous; the females as a rule are difficult to distinguish, *inter se*, and those of many species have not been described; but the males usually have distinctive antennae, the eleventh joint being often of remarkable shape, the tenth also is frequently peculiar. It is probable that the genus *Astychina* (10) will be found to be closely allied to, if not actually forming a section of it, the two apical joints of the antennae of *A. flavicollis*, *A. moerens*, and *A. funebris* differ quite as much from each other as do some species of *Heteromastix* with those joints distorted. So many species have been added since my table of the genus was published (11) that the following grouping should be of use:—

Antennae with third to fifth joints distorted in male.

DISTORTUS, Lea
INFLATUS, Lea

Antennae with ninth joint conspicuously dilated in male.

FUSICORNIS, Blackb
INSIGNICORNIS, Lea
MACLEAYI, Lea
MCDONALDI, Lea
NONARIUS, Lea

Antennae with eleventh joint (and usually the tenth) distorted in male.

BICOLOR, Bohem.
BISPINICORNIS, Lea
BRYANTI, Lea
CASTOR, Lea
CRASSICORNIS, Lea
DECIPIENS, Lea
DIORYCERUS, Lea
FLAVIFRONS, Lea
FLAVOTERMINALIS, Lea
FRATER, Lea
GAGATICEPS, Lea
GALEATUS, Blackb.
IMITATOR, Lea
LATICOLLIS, Lea
LONGICORNIS, Lea
LURIDICOLLIS, Macl.
MAJOR, Lea
MEDIOFUSCUS, Lea
MELANOCEPHALUS, Lea
MINOR, Lea
MIRABILIS, Lea
MIRUS, Lea
OBSCURIPES, Lea
OBSCURUS, Lea
PALLIPES, Lea
POLLUX, Lea
SCUTELLARIS, Lea
SPINICORNIS, Lea
TASMANIENSIS, Lea

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(10) Westwood, Trans. Ent. Soc. Lond., 1876, p. 494.

(11) Lea, *l.c.*, 1909, pp. 130-132.

Antennae with many joints distorted in male.

MIROCERUS, Lea

Antennae simple in both sexes.

A. Prothorax partly or entirely dark.

APICIFLAVUS, Lea
CRIBRIPENNIS, Lea
DISCOFLAVUS, Lea
FRAGILIS, Lea
GLABER, Lea
NIGER, Lea
PULCHRIPENNIS, Lea
TENUIS, Lea

B. Prothorax entirely pale

a. Elytra partly or entirely pale.

DENTICOLLIS, Lea
DOLICOCEPHALUS, Lea
FLAVIPENNIS, Lea
NIGRICEPS, Lea
NIGRIVENTRIS, Lea
TIBIALIS, Lea

b. Elytra entirely dark.

AMABILIS, Lea
ANGUSTUS, Lea
ANTICUS, Blackb
CASTIGATUS, Lea
COLLARIS, Lea
COMPAR, Lea
GENICULATUS, Lea
LATUS, Lea
MEGALOPS, Lea
NIGRIPES, Lea
OCCIDENTALIS, Lea
PAUXILLUS, Blackb.
PERABUNDANS, Lea
PUNCTICORNIS, Lea
PUSILLIOR, Lea
PUSILLUS, Bohem.
SERRATICORNIS, Lea
SIMPLEX, Lea
TARSALIS, Lea
TRICOLOR, Lea
VICTORIENSIS, Blackb.

HETEROMASTIX PUSILLUS, Bohem.

A specimen of this species, from Lucindale (South Australia) has a large, double, infuscate spot on the base of the prothorax.

HETEROMASTIX VICTORIENSIS, Blackb.

On the male of this species the ninth joint of the antennae is slightly longer and thicker than the eighth or tenth, and has a small fovea near its apex; Blackburn did not specially mention the ninth joint, and in fact its distinctive features could be easily overlooked, but they appear to connect the species with those having that joint conspicuously inflated (as in *H. mcdonaldi* and allied species) with those in which the antennae are simple in both sexes. Tasmanian specimens differ from mainland ones in having the knees no paler than the adjacent parts.

HETEROMASTIX TENUIS, Lea.

The female differs from the male in being somewhat shorter, antennae decidedly shorter, prothorax without a small subbasal notch on each side, and abdomen simple.

HETEROMASTIX MIRABILIS, Lea

The female differs from the male in being somewhat smaller, antennae thinner and simple, legs shorter, and in the abdomen; it is in fact scarcely distinguishable from the females of many other species of the genus, although the male is one of the most distinct.

HETEROMASTIX MACLEAYI, Lea.

Three males from Northern Queensland (Innisfail and Cairns) appear to belong to this species, but differ somewhat from each other and from the description of the type One in size and colour is like the type except that the four apical joints of its antennae are infuscated; the second is larger, 3 mm., and has the joints after the second infuscated, becoming almost black after the eighth, its elytra have the basal fifth flavous and sharply defined from the black; the third is still larger, 3·75 mm., and has the joints of the antennae, after the second, still darker, and slightly more of the elytra pale. A female, mounted with the second male, agrees well with it in colour and size, but has the antennae shorter (the three apical joints only about half the length of those in the male), with the ninth joint and the abdomen simple

HETEROMASTIX DOLICOCEPHALUS, Lea

On the male of this species the subapical segment of the abdomen is gently emarginate, the emargination becoming slightly stronger in the middle, not suddenly as in most males of the genus; the antennae are decidedly longer than in the female.

HETEROMASTIX AMABILIS, Lea.

Prior to being published this species was given the manuscript name of *elegans*, and was so noted in the table(12), afterwards the name was changed to *amabilis*, and unfortunately the necessary alteration was not made in the table

HETEROMASTIX BRYANTI, Lea. Figs. 1-3.

As the terminal joints of the antennae were not figured at the time of the description of this species, views of them, from different directions, are given for comparison with those of other species.

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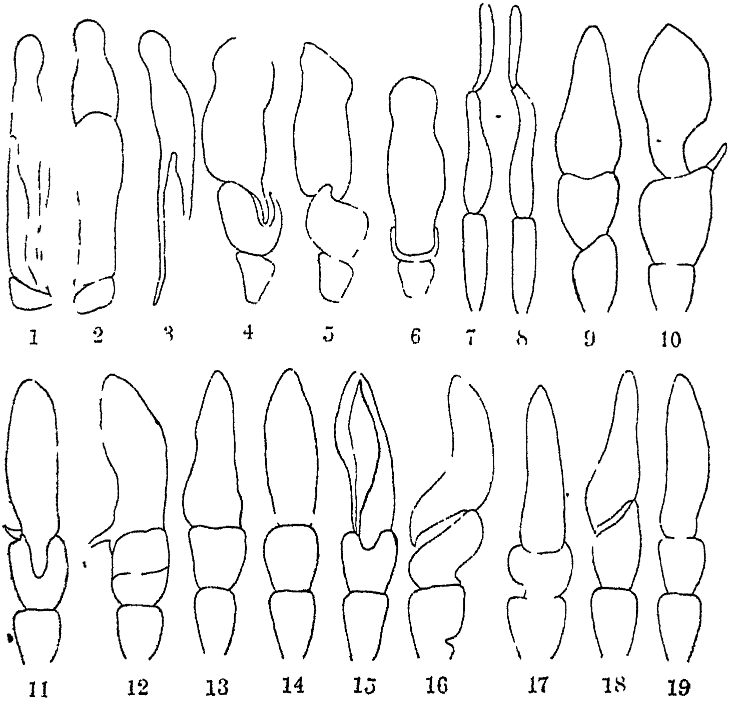
(12) Lea, Trans. Ent. Soc. Lond., 1909, p. 132.

HETEROMASTIX FLAVOTERMINALIS, Lea. Figs. 4-6.

Three figures of the terminal joints of antennae given for the same reason as those of the preceding species



TERMINAL JOINTS OF ANTENNAE OF SPECIES OF HETEROMASTIX.
1-3, *H. bryanti*; 4-6, *H. flavoterminalis*; 7, 8, *H. longicornis*; 9, *H. mediofuscus*; 10-12, *H. bispinicornis*; 13-15, *H. major*; 16, 17, *H. obscuripes*; 18, 19, *H. tasmaniensis*.

HETEROMASTIX NONARIUS, n. sp

♂. Black; head, prothorax, scutellum, mesosternum, legs, and basal joints of antennae flavous Moderately pubescent.

Head gently convex, with small prominent eyes. Basal joint of antennae about as long as second and third combined, second to fifth moderately transverse, sixth to eighth strongly so, ninth large, about as long as four preceding ones combined, evenly dilated from base but more produced on inner side of apex than on outer side (tenth and eleventh joints missing). *Prothorax* almost twice as wide as long; with a few submarginal punctures. *Elytra* parallel-sided to near apex; with dense and small, but sharply defined punctures. Length, 3 mm.

Hab.—Northern Queensland (Blackburn's collection). Type (unique), I. 11859.

In my table would be associated with *H. fusiformis*, from which it differs in being smaller, legs entirely pale, antennae with third to eighth joints decidedly transverse, and the ninth larger and of different shape; it is also close to *H. insignicornis*, but the seventh and eighth joints of antennae are at least twice as wide as long, instead of slighty transverse, the third joint also is no larger than the second.

HETEROMASTIX LONGICORNIS, n. sp. Figs. 7, 8.

♂. Black and flavous. With dense, short pubescence. *Head* gently convex, with two feeble interocular impressions. Antennae long and thin, fourth joint the length of first, slightly longer than third, and twice the length of second, the others somewhat longer, tenth and eleventh distorted. *Prothorax* twice as wide as long, margined throughout, the lateral margins slightly dilated and thickened near apex; with fairly large, submarginal punctures. *Elytra* long, thin, and almost parallel-sided to near apex; with dense and small punctures, many of which are sharply defined, but others transversely confluent. Subapical segment of *abdomen* triangularly notched in middle. *Legs* thin, but not very long Length, 3·5 mm.

Hab.—New South Wales: Dorrigo (W. Heron), Gosford (H. J. Carter). Type, I. 11863.

The antennae extend to the tips of the elytra, the distortion of the apical joints is very different from that of all other known species, the tenth is distinctly longer than the ninth and eleventh, and slightly thicker, from one direction it appears somewhat lopsided and from another sinuous, on top near the apex there is a shallow groove, as if for the partial reception of the eleventh; the latter is slightly longer than the ninth and strongly curved at the base. The pale parts are the head, prothorax, scutellum, a small part of base of elytra, and the sides to near apex (but the two colours not sharply limited), legs (parts of tarsi infuscated), and basal joints of antennae.

Two females, from Dorrigo, probably belong to this species, they differ from the males in having the head black, except for a variable portion of the muzzle, the scutellum black, the black of the elytra advanced to the base, except at the sides, where it is continued almost to the tips, antennae shorter, thinner, with simple joints, and abdomen not notched; on one of them its tip is flavous.

HETEROMASTIX MEDIOFUSCUS, n. sp. Fig. 9.

♂. Black; muzzle, prothorax, legs, two basal, and three apical joints of antennae flavous. With short and moderately dense pubescence.

Head shining, and with two feeble interocular depressions. Antennae moderately long, fifth and seventh joints slightly dilated on upper side, the sixth conspicuously dilated there, ninth joint longer than eighth, tenth and eleventh distorted, closely applied together, and about equal to the combined length of the seventh to ninth. *Prothorax* about twice as wide as long, sides slightly dilated and slightly thickened near apex. *Elytra* parallel-sided to near apex; with dense and small, but sharply defined punctures. Length, 3·5 mm.

Hab.—Queensland: Mount Tambourine (A. M Lea). Type (unique), I. 11864.

Apart from the antennae I cannot distinguish this species from *H. bicolor,* but the sixth joint is conspicuously produced on one side, although from some directions it appears even smaller than the adjacent ones; in colour it also approaches *H. mirocerus,* but the fourth to sixth joints of antennae of that species are very different. The third to sixth joints are pale on the under-parts, and infuscated above, the three following joints are almost black, the eleventh is so closely applied to the tenth that it is difficult to distinguish its junction with that joint; it appears to be somewhat helmet-shaped, although not much like that of *H. gagaticeps.*

HETEROMASTIX BISPINICORNIS, n. sp. Figs. 10-12.

♂. Black; prothorax, parts of under-surface of head, legs (tarsi infuscated), and two or three basal joints of antennae flavous. With very short pubescence.

Head feebly impressed between eyes. Antennae moderately long, two apical joints distorted. *Prothorax* almost twice as wide as long, margined throughout, sides slightly dilated to near apex. *Elytra* parallel-sided to near apex; with dense and small, rugose punctures. Length (♂, ♀), 4-4·5 mm.

♀. Differs in having the head smaller, antennae shorter, thinner, and simple, and abdomen not notched.

Hab.—Queensland: Mount Tambourine (A. M. Lea). Type, I. 11865.

The tenth joint of antennae of the male is rather large, and grooved on one side for the partial reception of the eleventh, from one direction it appears to be divided into two, so that the antennae seem to be twelve-jointed; the eleventh is about the length of the three preceding combined, fairly stout on the apical half, and strongly narrowed (on one side) to the base, near the base there are two spines, a rather short outer one directed outwards and forwards (from some directions this appears to belong to the tenth joint), and a longer one on the lower side, directed downwards and backwards. The colours are as on many other species, but the armature of the eleventh joint distinguishes from them all.

HETEROMASTIX MAJOR, n. sp. Figs 13-15.

♂. Black; prothorax, scutellum, labrum, parts of under-surface of head, and of three basal joints of antennae, knees and front coxae flavous. With very short pubescence.

Head shallowly depressed in front. Antennae rather long and not very thin, two apical joints distorted. *Prothorax* twice as wide as long, margined throughout, wider near apex than at base. *Elytra* parallel-sided to near apex; with dense and small, rugose punctures, coarser in middle than elsewhere. Subapical segment of *abdomen* deeply triangularly notched. Length, 6·5 mm.

Hab.—New South Wales (R. J. Burton). Type (unique), I. 12254.

The tenth joint of antennae is slightly shorter than the ninth, slightly wider at apex, somewhat lopsided, and with a notch at the apex on the under-surface; the eleventh is irregularly curved on one side, appears widest at base, and from another narrower than the tenth, and on its under-surface there is a long irregular groove; it has also a small basal spine invisible from most directions, and from some appearing to be attached to the tenth. Except for the labrum the upper-surface of the head is entirely black, and this with the pale scutellum associate the species in my table with *H. pallipes*, and *H. laticollis*, the former has legs almost entirely pale, and the latter with a greater portion dark, they have also different terminal joints; it is larger than any other species, having the elytra entirely dark and terminal joints distorted.

HETEROMASTIX OBSCURIPES, n. sp. Figs. 16, 17.

♂. Black; prothorax and parts of three basal joints of antennae flavous. With short, ashen pubescence.

Head with two small but distinct interocular impressions. Antennae moderately long and not very thin, three apical joints distorted. *Prothorax* about twice as wide as long, distinctly margined throughout *Elytra* parallel-sided to near apex; with dense and small, but sharply defined punctures, becoming somewhat larger about middle Length, 4 mm.

Hab.—Victoria: Dividing Range (Blackburn's collection). Type (unique), I 11868.

The seventh and eighth joints of antennae are slightly incurved on one side, and outcurved on the other, the ninth has a narrow notch near the base (invisible from most directions, but very distinct from others), the tenth has its apical portion hollow, and conspicuously produced on one side, and a subbasal notch somewhat larger than on the ninth, the eleventh is about as long as the two preceding combined, with a spine on one side of base, and the middle strongly incurved on one side. There are two small, round foveae, on the disc of the pronotum of the type; they are quite symmetrical, but their presence is possibly due to post-mortem contractions. No parts of the legs (except a small portion of the front coxae) are flavous, even the tibiae being deeply infuscated. In my table would be placed with *H. gagaticeps*, which has conspicuously bicoloured legs and very different antennae; it is closer to *H. laticollis* than to any other described species, but the scutellum is dark, the apical joint of the antennae is less strongly curved than on that species, but in much the same way.

HETEROMASTIX TASMANIENSIS, n. sp. Figs. 18, 19,

♂. Black; prothorax flavous, parts of three basal joints of antennae obscurely flavous. With rather dense pubescence.

Head with scarcely traceable frontal impressions. Antennae moderately long, third joint stouter than the others, tenth and eleventh distorted. *Prothorax* twice as wide as long, margined throughout. *Elytra* parallel-sided to near apex; with dense and small, sharply defined punctures, becoming larger about middle. Length, 3·25-3·5 mm.

Hab.—Tasmania: Cradle Mountain (H. J. Carter and A. M. Lea). Type, I. 12209.

The tenth joint of antennae on one side is slightly longer than the ninth, but on the other is conspicuously shorter, the eleventh has one side incurved towards the base, with the base itself on that side produced over the shorter side of the tenth, and with a small spine there. The abdominal notch is larger than usual. In my table would be placed with *H.*

gagaticeps, from which it differs in being smaller, legs entirely dark, darker basal joints of antennae, with apical joints different, and elytral punctures coarser; from the preceding species it differs also in being smaller, ninth and tenth joints not notched near base, the tenth longer on one side than the other, but not conspicuously produced there, and the eleventh less strongly incurved on one side. It is the only species known from Tasmania with the apical joints distorted.

HETEROMASTIX NIGRICEPS, n. sp.

♂. Black and flavous. With short, pale pubescence

Head with two faint interocular impressions. Antennae rather long and thin. *Prothorax* about twice as wide as long, margined throughout, lateral margins somewhat wider and distinctly thickened near apex. *Elytra* parallel-sided to near apex; with dense and small, but sharply defined punctures, becoming very small at tips and base. Length (♂, ♀), 3·5-4 mm.

♀. Differs in having the head smaller, with smaller and less prominent eyes, and shorter antennae.

Hab.—Northern Queensland (Blackburn's collection), Cairns (Dr. E. W. Ferguson). Type, I. 12257.

The black parts are the head (except mentum), mesosternum, metasternum, and abdomen; on some specimens some of the antennal and tarsal joints, and the coxae, are rather lightly infuscated, on others the legs and antennae are entirely pale. On both sexes (there are two pairs taken *in cop.* before me) the abdomen is notched, but the notch is much larger on the male than on the female. In my table would be associated with *H. flavipennis*, but is a much smaller species, with finer punctures and prothoracic margins much as in *H. pusillus*, to which it is structurally closer.

HETEROMASTIX DENTICOLLIS, n. sp.

♂. Flavous; head, metasternum, and abdomen blackish, antennae (except some of the basal joints) deeply infuscated, middle and hind coxae, parts of femora and of tarsi rather lightly infuscated. With short, pale pubescence.

Head with two vague interocular impressions. Antennae long and thin. *Prothorax* at widest more than twice as wide as long, with fine margins, but each side suddenly and strongly dilated and thickened towards apex. *Elytra* long, thin, and almost parallel-sided to near apex; with dense and small, but sharply defined punctures. Length, 3-3·25 mm.

Hab.—Northern Queensland (Blackburn's collection). Type, I. 12261.

A narrow, fragile species, in many respects close to the preceding one, but at once distinguished by the lateral margins of the prothorax; these are suddenly and strongly dilated somewhat nearer the apex than base, so as to appear like a large obtuse tooth on each side; on the preceding species the margins are somewhat dilated near apex and thickened there, but the increase is neither sudden nor strong. A second specimen differs from the type in having the dark parts of the femora almost black..

HETEROMASTIX PULCHRIPENNIS, n. sp.

♂. Black; elytra deep purple. With short, dark pubescence

Head with two small, transverse, interocular impressions. Antennae moderately thin, extending to about middle of elytra, second joint more than half the length of third, eleventh distinctly longer than tenth. *Prothorax* almost twice as wide as long, sides and base distinctly margined, the former almost parallel. *Elytra* parallel-sided to near apex, with dense and sharply defined punctures of moderate size. Length, 3 mm.

Hab.—Queensland · Coen River (W. D. Dodd). Type (unique), I. 11869.

In my table would be placed with *H. niger*, but the elytra are purple, prothorax more parallel-sided, and antennae no longer than in its female.

HETEROMASTIX FRAGILIS, n. sp.

♂. Dark piceous-brown, elytra, under-surface of head, legs, and three basal joints of antennae obscurely pale. With short, ashen pubescence.

Head vaguely impressed between eyes. *Antennae* long and thin, third joint twice the length of second, and slightly stouter than the following ones. *Prothorax* about twice as wide as long, hind angles widely rounded, sides slightly dilated to near apex, and somewhat thickened at widest part. *Elytra* long and thin; with dense, small, and somewhat rugulose punctures.' Length, 2 mm.

Hab.—Northern Queensland (Blackburn's collection). Type, I. 11873.

A minute, dingy, fragile species. Its prothoracic margins are slightly paler than the disc, and so the species could hardly be referred to B or BB of my table, but regarding it as belonging to BBB of that table, it would be distinguished from the species placed there by its minute size; it is in fact smaller than any species noted in that table, but there are others equally small now before me.

HETEROMASTIX NIGRIVENTRIS, n. sp.

♂. Flavous; apical three-fifths of elytra, abdomen, and eight or nine apical joints of antennae black. With rather short, pale pubescence.

Head feebly impressed between eyes. Antennae moderately long and thin, third joint slightly stouter than the following ones. *Prothorax* about twice as wide as long, margined throughout, sides slightly dilated to near apex, and somewhat thickened near apex *Elytra* slightly dilated beyond the middle; with dense and small, but sharply defined punctures. Length (♂, ♀), 2·5-3 mm.

♀. Differs in having the head smaller, eyes less prominent, antennae shorter, and in the abdomen.

Hab.—Northern Queensland (Blackburn's collection), Cairns (Dr. E. W. Ferguson). Type, I. 11871

The black part of the elytra is somewhat rounded in front, so that the flavous portion is advanced along the sides to beyond the middle; on some specimens some of the antennal joints beyond the third are hardly more than infuscated. In my table the entirely pale prothorax and bicolorous elytra readily distinguish it from all species having simple antennae; structurally it approaches *H. pusillus;* the simple front legs readily distinguish it from *H. tibialis.*

HETEROMASTIX COMPAR, n. sp.

♂. Black; head, prothorax, scutellum, mesosternum, two basal joints of antennae, and knees flavous, rest of legs more or less deeply infuscated. With short, ashen pubescence.

Head with a narrow, oblique impression, on each side of middle in front. Antennae rather long and thin, tenth joint partly shining, and with a small fovea near apex. *Prothorax* less than twice as wide as long, margins rather wide at base and sides, and narrow across apex, sides widest but not thickened near apex; with distinct, submarginal punctures. *Elytra* parallel-sided to near apex; with dense and sharply defined punctures of moderate size. Length, 2·75-3 mm.

Hab.—Northern Queensland (Blackburn's collection), Kuranda (F. P. Dodd). Type, I. 11874.

The tenth joint of the antennae, on three males before me, has a small subapical fovea or puncture on a small shining place, on the type the joint itself is slightly longer and thicker than the eleventh; on the other males it is no thicker, and is slightly shorter than the eleventh; on two of them (including the type) the cephalic impressions are almost conjoined in front to form a V, on the other they are much less distinct. In my table would be placed with *H. anticus*, and *H. geniculatus*, from which it is readily distinguished by the tenth joint; from the former it is also distinguished by its smaller size and less conspicuously bicoloured legs, and from the latter also by only having two basal joints of antennae pale.

A female, mounted with one of the males by Mr. Blackburn, possibly belongs to the species, but has the head black, and differs in other (probably sexual) characters.

HETEROMASTIX ANGUSTUS, n. sp.

♂. Flavous; elytra, metasternum, abdomen, and antennae (three or four basal joints excepted) deeply infuscated. With short, ashen pubescence.

Head with two feeble interocular impressions. Antennae long and thin. *Prothorax* about twice as wide as long, base and apex finely margined, sides suddenly and strongly dilated, or obtusely dentate, rather nearer apex than base *Elytra* long and thin; with small and crowded, somewhat rugose punctures. Length, 2·25-2·5 mm.

Hab.—Northern Queensland: Blackburn's collection. Type, I. 11879.

A thin, dingy species, structurally close to *H. denticollis*, but head and prothorax flavous; the sides of the prothorax are an exaggeration of those of *H. pusillus*, but the antennae are decidedly longer than in that species, the eyes are slightly larger, and the whole insect is smaller It is the smallest and thinnest of all the species having entirely dark elytra and pale head.

HETEROMASTIX COLLARIS, n. sp.

♂. Black; prothorax, part of under-surface of head, and front coxae flavous. Densely clothed with short pubescence.

Head gently depressed between eyes, with a slight longitudinal elevation near each antenna. Antennae long and rather thin, third joint stouter than the following ones. *Prothorax* less than twice as wide as long, margined throughout, sides slightly but regularly increasing in width from base to near apex, and then strongly rounded to apex itself, which is not quite as wide as base. *Elytra* almost parallel-sided to near apex; with crowded and small punctures (almost shagreened). Length (♂, ♀), 6-7 mm.

♀. Differs in having the head smaller, antennae about one-third shorter, and in the abdomen.

Hab.—Victoria: Dividing Range (Blackburn's collection), South Wandin (H. H. D. Griffith from E. Jarvis). Type, I. 12259.

The sides of the prothorax are much as those of *H. geniculatus*; but the head and knees are black; the sides are intermediate between those of the species of the *pauxillus* (F) and *pusillus* (FF) groups of my table, in *H. amabilis* the angulation is slightly more pronounced, the third and fourth joints of its antennae are thinner, and the knees are pale; *H. simplex* is smaller, with much shorter antennae, more distinct elytral punctures and pale knees; *H. pauxillus*, which it closely resembles in size and colour, has decidedly thinner antennae, and sides and front angles of prothorax different; there are a few submarginal punctures on the prothorax, but they are much less distinct than on *H. victoriensis*, which also has the sides of the prothorax evenly rounded, knees (on the typical form) paler than the adjacent parts, and elytral punctures much more sharply defined

HETEROMASTIX SERRATICORNIS, n. sp.

♂. Black; prothorax, part of under-surface of head, two basal joints of antennae, and part of the third, and legs (tarsi and parts of tibiae infuscated) flavous With short pubescence.

Head gently depressed in front. Antennae moderately long, rather thin, third to tenth joints slightly serrated on one side. *Prothorax* less than twice as wide as long, margined throughout, lateral margins slightly and evenly rounded and slightly thickened near apex; with submarginal punctures *Elytra* slightly wider near apex than at base; with crowded and small rugose punctures. Length (♂, ♀), 4·5-6 mm.

♀. Differs in having the head smaller, antennae about one-third shorter and not serrated, prothorax with margins nowhere thickened, and in the abdomen.

Hab.—New South Wales: Brindabella (Blackburn's collection), Jindabyne, in January, and Sydney (H. J. Carter). Type, I. 11876.

On each of three males and five females the tips of the front tibiae, half of the middle and three-fourths of the hind ones are infuscated; on one of the males the base of the hind femora and hind coxae are infuscated, and on two of the females the middle and hind femora are deeply infuscated in parts. The serration of the antennae of the male is slight, but quite distinct from some directions; in *H. pauxillus* they are not serrated, on the female of the present species they are also not serrated, but they are scarcely half the length of those of that species, which is also narrower and with darker legs; *H. simplex* has shorter and non-serrated antennae, elytral punctures more distinct, and more of legs dark, the antennae of its female, however, are very similar. In appearance it is closest to *H. latus*, but is somewhat narrower, antennae longer and more strongly serrated in male, the terminal joint not constricted in middle, and more of the legs and less of the head pale.

LAIUS SINUS, Lea.

A specimen, from Gosford, the locality of the type, is evidently a female of this species, its apparent second joint (really the third) of antennae is much larger than is usual in females (but in this it resembles the female of *L. flavonotatus)* but much smaller than in the male and simple, from the male also it differs in having the following joint reddish, less of the muzzle reddish, the head with very small punctures, and the front tarsi and abdomen simple.

LAIUS FLAVIFRONS, Lea.

Two males, from Parachilna (South Australia), differ from the type in having two narrow dark lines extended in front from the dark interocular space, parts of the undersurface of the two basal joints of antennae (in error in the original description (13) the second joint was referred to as the "basal" one) and the legs entirely dark; the dark subapical markings of the elytra are also connected across the suture. One of the specimens has a black blotch, with a greenish gloss, occupying rather more than the median third of the prothorax, touching its base but not apex; this specimen at first glance somewhat resembles *L. nidicola*, *L. intermedius*, and *L. villosus*, all of which have much larger punctures on the elytra, and very different antennae.

LAIUS PALLIDUS, Lea.

A male, from Parachilna, with antennae identical with those of the type, has the dark part of the elytra not in the form of sharply limited spots, but more like a deep stain, irregularly occupying most of the basal two-thirds, with a whitish spot, completely isolated at the basal third, on each elytron; its scutellum is black.

LAIUS VERTICALIS, W. S. Macl.

A male of this species, from Wyndham (North-western Australia), is somewhat smaller than the females before me; the basal joint of its antennae is large, and with a process obliquely placed, so that from some directions the process itself appears narrow, parallel, and elevated at right angles from the mass of the joint, from other directions it appears to be subtriangular, with its hind part vertical, and front part curving to the apex, from other directions the whole joint appears like a thick, barbless hook; the apparent second joint is large, convex on the lower-surface, and irregularly concave on the upper; the second joint of its front tarsi is stout, and longer than the two following ones, which from some directions it entirely conceals, it is also tipped with black. It is certainly close to the male of *L. tarsalis*, but the head is without the interrupted ridge between the eyes which causes the head of that species, when viewed from behind, to appear conspicuously notched in the middle, the head of the present species, when so viewed, appears to have a gently even incurvature between the eyes.

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(13) Trans. Roy. Soc. S. Austr., 1917; p. 138, fourth line.

LAIUS CINCTUS, Redt.

A male, from Townsville, is much below the average size of this species, has shorter antennae (the three apical joints are notably stouter than on the typical form), and front femora pallid, but as the distorted joints of the antennae are almost exactly the same, and the front femora are foveate, it should probably be regarded only as a variety of the species.

LAIUS ARMICOLLIS, Lea.

A male of this species, from Sea Lake (Victoria), in Mr. Goudie's collection, has the pale parts almost scarlet, no doubt the normal colour of living specimens. Two females, from Leigh Creek (South Australia), evidently belong to the species; they differ from the male in having the head green, except for the flavous muzzle, and without excavations, the prothorax unarmed and immaculate, and the second joint of the front tarsi normal.

LAIUS EFFEMINATUS, n. sp.

♂. Metallic purplish-blue, prothorax, three spots on elytra, under-surface of basal joints of antennae, and part of abdomen reddish. With rather dense, erect, blackish hairs.

Head gently convex, with two feeble depressions in front; punctures small and sparse. Antennae obtusely serrated, apparent second joint simple, almost as long as two following combined. *Prothorax* widely transverse, sides strongly rounded, base feebly bilobed; with fairly large, scattered punctures, becoming numerous on sides. *Elytra* slightly dilated to near apex, sides and suture thickened; with crowded, rugose punctures, becoming sparser (but still dense) and more sharply defined near scutellum, and at apex. Front *femora* simple; second joint of front tarsi large, lopsided, partially concealing third and fourth, and with a black outer comb. Length (♂, ♀), 4-5·5 mm.

♀. Differs in having the head smoother in front, antennae slightly shorter and thinner, elytra more dilated posteriorly, and second joint of front tarsi similar to the third.

Hab.—Victoria: Melbourne, in September (F. E. Wilson); Geelong (H. W. Davey). Type, I. 12215.

One of the few species of the genus with antennae practically identical in the sexes. The pale markings of the elytra consist of a fairly large spot, common to both, at the apex, and a narrow spot on the middle of each side, varying from one-third to one-fifth the length of the elytra; but on one female the lateral spots are absent. The antennae, scutellum, under-surface, and legs are less blue than the head and elytra; they might be regarded as black, with a bluish gloss; on some specimens parts of the elytra have a slight greenish gloss. On each of the nine specimens examined the elytra do not quite cover the abdomen; on the male the tip of the latter is deeply notched, on the female it is but feebly notched.

LAIUS JANTHINIPENNIS, n. sp.

♂. Black with a purplish gloss, elytra deep purple, prothorax and parts of basal joints of antennae flavous. With sparse, ashen pubescence, and erect, dark hairs.

Head with a narrow curved line connecting bases of eyes, front shallowly depressed and subtriangular; with minute punctures. Antennae with first joint large, its inner apex produced into a truncated lamina, apparent second joint large, its lower-surface gently convex and irregularly four-sided, upper-surface irregularly concave and deeply notched to receive lamina of first joint, the following joints feebly serrated. *Prothorax* strongly transverse, sides strongly rounded, base gently bilobed, a wide shallow depression near base; sides with fairly numerous punctures, sparse elsewhere. *Elytra* parallel-sided to near apex, sides and suture thickened; basal sixth and apical third shining and with sparse punctures, the intervening space subopaque, and with crowded, rugose punctures. Second joint of front *tarsi* rather large and lopsided. Length, 3 mm.

Hab.—Queensland: Roma (Dr. E. W. Ferguson). Type, I. 12216.

A very distinct species of medium size, and the only one known to me having prothorax entirely pale, and elytra entirely dark. In some respects it is close to the description of *L. asperipennis*, but is smaller, prothorax immaculate, two joints of each antennae partly pale, and muzzle dark.

LAIUS INTRICATUS, n. sp.

♂. Black, in parts with a greenish or bluish gloss; elytra bright red, with purple markings, suture black, all margins of prothorax, parts of muzzle, and parts of basal joints of antennae reddish. With sparse, ashen pubescence, and erect, brownish hairs.

Head densely granulate-punctate. Antennae with first joint dilated and irregular at apex, apparent second large, lower-surface gently convex and lopsided, upper-surface with a large excavation near base, and a semi-double one near apex, following joints more or less distinctly serrated, apical one almost twice as long as the preceding one. *Prothorax* almost twice as wide as long, sides evenly rounded, irregularly depressed near base; margins with irregular punctures, small and sparse elsewhere. *Elytra* almost parallel-sided to near apex, sides and suture thickened; with crowded but sharply defined punctures in middle, becoming sparser about base and apex. Second joint of front *tarsi* rather large, lopsided, with a black outer comb. Length (♂, ♀), 4·5-5 mm.

♀. Differs in having the head smaller, with smaller punctures, basal joints of antennae entirely pale, the first about as long as in the male but only about half as thick at apex, the apparent second simple, about as long as two following combined, and second joint of front tarsi much the same as third.

Hab.—South Australia: Port Broughton (A. M. Lea), Fowler Bay (C. French). Type male, I. 11881, in South Australian Museum; type female, in National Museum.

A curiously marked species. The red of the elytra is brighter but otherwise almost as in *Novius cardinalis*; the purple part on each elytron is directed backwards from the shoulder, on the inner side curves round to the suture at the basal third, from the main portion is continued and at the apical third is directed on one side to the margin, along which it continues for a short distance, on the other side it turns round to meet a large, somewhat diamond-shaped mark on the suture, as a result (combined with the black suture) there are four isolated red patches on each elytron: a round one near the scutellum, an irregularly four-sided medio-sutural one, a large irregular apical one, and a narrow lateral strip on the basal half; the large dark part of the pronotum is gently incurved to the middle in front, dilated on each side, and bilobed at base.

LAIUS TRIFOVEICORNIS, n. sp.

♂. Dark purple, some parts blackish: prothorax, apex of elytra, basal joints of antennae, and most of legs flavous. With sparse, ashen pubescence, and long, dark hairs.

Head gently concave in front; with dense and small punctures. Antennae with first joint dilated at apex, apparent second very large, lower-surface gently convex, upper-surface with three irregular excavations *Prothorax* strongly transverse, sides strongly rounded; with fairly dense punctures on sides, sparse elsewhere. *Elytra* almost parallel-sided to near apex, sides and suture slightly thickened, apex base and sides with rather small and rugose punctures, denser, larger, and more rugose elsewhere. Second joint of front *tarsi* lopsided, with a black outer comb. Length (♂, ♀), 2·75-3 mm.

♀. Differs in having the head smaller, apparent second joint of antennae simple, and second joint of front tarsi similar to the third.

Hab.—Australia (old collection); South Australia: Moonta (Blackburn's collection). Type, I. 7582.

The elytra are coloured almost as in *L. miroceru*s, but the two species have little else in common, from some directions they appear to be multigranulate. The pale apical portion occupies about one-fourth of the length at the suture, where it is longest, and then curves round to each side so as to resemble the figure 3, but it is very narrowly continued along each side almost to the base; the antennal joints, after the apparent second, are more or less infuscated.

LAIUS ALBOMACULATUS, n. sp.

♂. Black; parts of basal joints of antennae flavous, four large spots, and parts of extreme base of elytra, almost white. With fairly numerous, erect, dark hairs.

Head gently convex, with a small fovea in middle and two feeble depressions in front; with dense and sharply defined punctures. Antennae with first joint moderately long, the apparent second much larger, gently convex on lower-surface, irregularly concave on upper-surface, the outer front angle conspicuously produced, many of the following joints transverse. *Prothorax* widely transverse, apex much wider than base, a shallow depression near base; with dense and sharply defined punctures on sides, sparser elsewhere. *Elytra* with sides slightly dilated to near apex, sides and suture thickened; with dense and sharply defined punctures on most of the dark parts, sparser and smaller on the pale parts. Second joint of front *tarsi* lopsided, with a black outer comb. Length, 2·5 mm.

Hab.—South Australia: Tarcoola (A. M. Lea). Type (unique), I. 12217.

A small, very distinct, black and white species, in some respects like *L. flavonotatus*, but antennae of different shape and elytral spots and punctures very different. The pale basal parts of the elytra are normally concealed by the prothorax; two of the spots are at the basal third, and appear as parts of a fascia widely interrupted at the suture, and not touching the sides; the other spots are apical, and very narrowly separated by the suture.

LAIUS INCONSTANS, n. sp.

♂. Flavous and black or infuscated. Clothed with sparse, ashen pubescence, and a few longer hairs.

Head wide and gently convex; with dense sharply defined punctures. Antennae with basal joint fairly large, the apparent second much larger, gently convex on lower-surface, upper-surface with a curved ridge bounding two large unequal excavations, apical corners somewhat produced, many of the following joints slightly transverse. *Prothorax* about twice as wide as long, sides strongly rounded, a shallow depression near base; with fairly dense and rather sharply defined punctures on sides, sparse elsewhere. *Elytra* almost parallel-sided to near apex, sides and suture thickened; densely and irregularly granulate-punctate, the punctures smaller and sparser about base and tips than elsewhere. Second joint of front *tarsi* large, lopsided, and with a black outer comb. Length (♂, ♀), 2-2·75 mm.

♀. Differs in having the head smaller, the apparent second joint of antennae simple, and about as long as the two following combined, prothorax less transverse, and second joint of front tarsi simple.

Hab.—South Australia: Barton (A. M. Lea), Murray River (A. H. Elston and R. F. Kemp). Type, I. 12218.

In general appearance approaches the variety of *L. pallidus* described from Parachilna, but the antennae very different. Of the four specimens before me no two are exactly alike in colours. The type male has the head flavous, with the basal half slightly infuscated, the prothorax is almost black, with all the margins narrowly flavous, the scutellum is black, the elytra at the extreme base (normally concealed by the prothorax) are flavous, then there is a fairly wide blackish fascia touching the suture but not the sides, then a fairly wide, almost white one, touching the sides but not the suture, then a wider blackish one touching the sides, and narrowly interrupted at the suture, and then about the apical fourth is flavous; the tarsi and tip of antennae are also infuscated A second male has the head entirely pale, the prothorax pale except for a large infuscated spot on each side, the dark parts of the elytra less blackish, and the pale fascia at the median third larger; most of the antennae and of the tibiae are also infuscated. The type female has the head, prothorax, scutellum, antennae (except the extreme tips), and legs flavous, with the dark basal fascia not much darker than the pale one following it, and the postmedian one hardly infuscated. On the second female the base of the head and part of the prothorax are vaguely infuscated, and the elytral markings are very obscurely defined, the infuscation of the legs is also slight. As with other males of the genus the apparent second joint of the antennae appears of different shape from almost every point of view.

HYPATTALUS PUNCTULATUS, Blackb.

Although *Hypattalus* was proposed by Blackburn on species that differed in their tarsi from typical species of the genus *Attalus*, and the male tarsi of the latter were commented upon, he did not denote the sex of either *H. punctulatus*, or *H. elegans* (described on the same page), and there were no particulars given (the legs, except as to their colour, were not mentioned in either description) that can be relied upon to determine the sex. When the major portion of his collection was acquired by the South Australian Museum there was one cotype of *punctulatus* in it, this specimen is a female. Two males, from Adelaide and Mount Lofty, belong to the species, and differ from the female in having part of the muzzle pale, the antennae longer and strongly serrated, and the hind tibiae thickened, and foveate in the middle of the outer side, with part of the foveated portion red. In the male of *H. elegans* the distorted portion is slightly nearer the base, and is not foveate externally. The two species are certainly distinct, but they both have decidedly blue elytra. Another male, from Victoria, however, has the elytra of such a deep purple as to be almost black.

HYPATTALUS SORDIDUS, Lea.

Of two specimens taken by Mr. F. E. Wilson, in Victoria, one has a dark median line on the prothorax and more of its sides dark than usual; the other has the prothorax entirely pale.

HYPATTALUS ALPHABETICUS, Lea.

Two specimens, sexes, from Parachilna (South Australia) probably belong to this species, but differ from the type in being considerably larger (♂, 2·75; ♀, 3 mm.), the dark parts of the elytra metallic-blue instead of violet, with the subapical spots more nearly circular, and touching the suture, the pale portion the same shade as the prothorax, instead of paler, the punctures across the middle fairly coarse, and the antennae (except the under-surface of some of the basal joints) deep black. The female differs from the type (also a female) in having the antennae decidedly shorter and stouter, the legs darker, with the hind ones black. The male has decidedly longer antennae than in the Parachilna female, of the same proportionate length as those of the type, but the serrations are stronger; its hind legs are missing, but the front and middle femora and tibiae are palè; the front femora are simple.

HYPATTALUS INSULARIS, Lea.

A specimen, from the Dividing Range (Victoria), evidently belongs to this species, but has tibiae entirely dark; the prothorax is flavous with a large infuscate discal blotch, and its punctures are less distinct than on the types; the elytra have vague remnants of striation (as on the types). A specimen, from Sydney, has legs as in the type, but the prothorax entirely flavous.

HYPATTALUS FLAVOAPICALIS, n. sp

♂. Black; tip of elytra, apical segment of abdomen, parts of under-surface of antennae, and of under-surface of muzzle, trochanters, and parts of coxae flavous With sparse, short, ashen pubescence, and rather numerous erect, dark hairs.

Head moderately convex between eyes, with two shallow conjoined depressions in front; punctures rather sparse and minute, becoming denser at base. Antennae rather long, feebly serrated, seventh joint slightly longer than the adjacent ones, and the length of eleventh. *Prothorax* strongly transverse, sides (except in front) and base obliquely margined: with a few scattered punctures. *Elytra* parallel-sided to near apex, sides and suture slightly thickened, the apex more strongly so; with rather large, crowded, and sharply defined punctures. Apical segment of *abdomen* rather large. Hind *tibiae* moderately curved. Length (♂, ♀), 4-4·5 mm.

♀. Differs in having the head smaller, with shallower frontal depressions, antennae shorter and thinner, legs shorter, and apical segment of abdomen softer.

Hab.—Tasmania: Cradle Mountain (H. J. Carter and A. M. Lea), Waratah (Lea). Type, I. 12248

In my table of the genus (14) would be associated with

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(14) Lea, Trans. Ent. Soc. Lond., 1909, p 169.

H. enilis and *H. montanus*, but differs from each in the pale markings of elytra being confined to the apex. On the male the elytra have a faint greenish gloss; the apical segment of its abdomen is smooth and appears to be hard (as in the male of *H. apiciventris*); on the female, although similarly coloured, it is irregularly wrinkled, as a result of post-mortem contractions. A single specimen was taken at each locality.

HYPATTALUS TRICOLOR, n. sp.

♂. Black; elytra violet-blue, their tips, prothorax, scutellum, and abdomen flavous; parts of legs and of basal joints of antennae obscurely diluted with red. Upper-surface almost glabrous.

Head with very feeble depressions in front; with sparse and minute punctures. Antennae moderately long, not very thin, obtusely serrated. *Prothorax* strongly transverse, sides and base thinly margined; almost impunctate. *Elytra* parallel-sided to near apex, sides and suture thickened, the apex still more so; with rather minute but sharply defined punctures, nowhere crowded, but in places rather numerous. Front *femora* moderately curved and edentate. but trochanter long, thin, and truncated, hind tibiae rather long and strongly curved. Length, 2·5 mm.

Hab.—Northern Queensland (Blackburn's collection). Type (unique), I. 11885.

The curvature of the front femora, with the very conspicuous front trochanters, associate this species with *H. australis* and its allies; the only one of these having similarly coloured elytra is *H. apicipennis*, which has elytral punctures crowded (although sharply defined) on most of its surface, very different to those on the present species, which also has the abdomen pale. There are several somewhat similarly coloured species (*H. viridis* and *H. violaceus*), but with normal front legs in the male.

A female, from New South Wales (Blackburn's collection), probably belongs to this species, but has slightly larger elytral punctures (although nowhere crowded), its colours are exactly as in the type, from which it differs also in having antennae shorter, and front legs simple.

HYPATTALUS INCONSPICUUS, n. sp.

♂. Black, prothorax flavous; parts of four or five basal joints of antennae, trochanters, parts of coxae and parts of front and of middle tibiae obscurely flavous. With sparse, ashen pubescence.

Head with shallow depressions in front, and with rather sparse punctures. Antennae moderately long and obtusely serrated. *Prothorax* strongly transverse, sides and base with thin margins; sides with fairly distinct punctures, sparse elsewhere. *Elytra* with sides feebly dilated from near base to beyond the middle, sides and suture slightly thickened; with sharply defined and dense, but not crowded, punctures. *Legs* long and thin, hind tibiae rather strongly curved. Length, 1·75-2 mm.

♀. Differs in having the head slightly smaller, with thinner antennae, elytra slightly wider, legs slightly shorter, and in the tip of the abdomen.

Hab.—New South Wales: Blue Mountains (Dr. E. W. Ferguson). Type, I. 12220.

In appearance like small specimens of *H. calcaratus*, from which it differs in the thinner antennae, and hind tibiae of female not spurred; *H. abdominalis* is somewhat larger, elytra with smaller punctures, and antennae much shorter and distinctly serrated.

HYPATTALUS MINUTUS, n. sp.

Black; a small part of muzzle, basal parts of legs, and parts of basal joints of antennae obscurely testaceous. Upper-surface almost glabrous.

Head almost impunctate, an oblique depression each side in front. Antennae moderately long, thin, and obtusely serrated. *Prothorax* strongly transverse, sides and base finely margined; almost impunctate. *Elytra* rather distinctly dilated to near apex; with minute, rugulose punctures. *Legs* long and thin. Length, 1 mm.

Hab.—South Australia: Kangaroo Island (A. H. Elston). Type, I. 12219.

The smallest Australian species of the Malachiides, being only about half the bulk of *H. parvoniger*, its nearest ally. The tarsi are narrower than is usual in the genus, and the exoskeleton seems to be unusually soft; as a result the five specimens taken by Mr. Elston all differ in apparent shape, owing to post-mortem contractions.

CARPHURUS and BALANOPHORUS.

Owing to the fact that the females, as well as the males, of *Balanophorus* have a comb on the basal joint of the front tarsi, and that in *Carphurus* it is the males only that have such a comb, I was led astray, and described as male *Carphuri* specimens that were really female *Balanophori*. In my table (15) the species that need reconsideration in this respect are those referred to "G. Antennae subpectinate or very strongly serrate." Upon these the following comments are offered:—

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(15) Lea, Trans. Ent. Soc. Lond., 1909, pp. 188-191; in the table the top line of page 190 should have been *kk* not *nn* (to mate with *k* on page 189).

elegans, Lea. The comb on the front tarsus of each of the types is unusually long, and as the serrations of the antennae are rather less pronounced than in females of *Balanophorus* it was probably correctly referred to *Carphurus*.

longipes, Lea. The type is in the Macleay Museum, and I have not re-examined it.

variipennis, Lea. The type female is without combs, and so is a *Carphurus*, the serrations of the antennae of the male are very pronounced. A male in Mr. Carter's collection, from Stradbroke Island, has the middle femora entirely pale, and the hind ones dark only at the apical third; a female, in the Queensland Museum, has the elytra entirely pale.

lepidus, Lea. The type has combs and in appearance is very similar to a female of *B. scapulatus*, but its elytral punctures are denser and sharply defined, and hence it is probabaly a *Carphurus*.

maculiventris, Lea. The type is a female without combs, and so is a *Carphurus*.

apiciventris, Lea. The type of the species and a specimen of the variety *dubius* have combs, but until both sexes are known it is desirable to leave the species in *Carphurus*.

bifoveatus, Lea. Although in general appearance very close to *B. janthinipennis* the female is without combs and so is a *Carphurus*.

triimpressus, Lea. See note as *Balanophorus triimpressus*.

pictipes, Lea. Two females are combless, and so belong to *Carphurus*.

rhagonychinus, Fairm. See note as *B. rhagonychinus*.

simulator, Lea. The type has combs and is probably a female *Balanophorus*, as structurally it is very close to a female of *B. rhagonychinus*.

BALANOPHORUS BREVIPENNIS, Germ.

Two specimens, sexes, of this species in Mr. F. E. Wilson's collection, from Gisborne (Victoria), have the head entirely red.

BALANOPHORUS PICTUS, Lea.

A male, from Melville Island, in the National Museum, has the greater portion of the legs black, but otherwise agrees well with a cotype of this species. A specimen from the Forrest River (North Western Australia) is evidently a female of the species, its colours are much as in the male, except that the tip of the abdomen is black, that parts of the tibiae are infuscated, and that the blue of the elytra occupies more of the surface; the antennae are strongly serrated only.

BALANOPHORUS TRIIMPRESSUS, Lea (formerly CARPHURUS).

Deceived by its tarsal combs I described the type of this species as a male *Carphurus*, but Mr. F. E. Wilson has recently taken, at Ringwood in Victoria, a true male of the species, and it is a *Balanophorus*, with long rami on the antennae after the third joint. It has denser and smaller, but more sharply defined punctures on the elytra than on *B. janthinipennis*, from which, as also from *B. victoriensis*, it may be distinguished by the eyes being much larger; on the female they are as large as on the males of those species, and on the male about twice as large, being almost as large as on the male of *B. scapulatus*.

BALANOPHORUS RHAGONYCHINUS, Fairm. (formerly CARPHURUS).

This species is also a *Balanophorus*, its male having flabellate antennae much as in the above species, and in *B. scapulatus;* its eyes are much as in the latter species. In both sexes the femora and tibiae vary from entirely pale to entirely dark; on the female the femora are often infuscated in the middle, on one female the only dark part of the head is a conspicuous fascia connecting the eyes. Specimens before me are from Sydney, Blue Mountains, Eden, Kangaroo Valley, and Mittagong, in New South Wales; and near Brisbane, in Queensland.

BALANOPHORUS JANTHINIPENNIS, Fairm.

Two specimens, sexes, from Galston, differ from the typical form of this species in having the abdomen dark, except for the sides of the three basal segments, the elytra blackish-purple, and the second joint of antennae entirely pale: the elytral punctures are also smaller, although much more distinct than on *B. victoriensis*.

BALANOPHORUS CONCINNUS, n. sp.

♂. Flavous; elytra (except extreme base), and apical two-thirds of hind femora black, part of metasternum, eight apical joints of antennae, tarsi, and hind tibiae more or less deeply infuscated. With blackish hairs, denser on elytra, and longer on sides of abdomen, than elsewhere.

Head rather wide, a shallow depression each side in front; base punctate and transversely strigose. Each eye less than half the width of the inter-ocular space. Antennae with third joint acutely produced on one side, each of the seven following joints with a long ramus. *Prothorax* slightly longer than wide, sides gently rounded, a shallow depression near base. *Elytra* about twice as long as wide, with dense, small and distinct, but not very sharply defined punctures. Basal joint of front *tarsi* large, lopsided, partly concealing second joint, with a black comb from base to apex on inner side. Length, 6 mm.

Hab.—Queensland: Cairns district (F. P. Dodd). Type (unique), I. 11954.

About the size of the typical form of *B. scapulatus*, but with much smaller eyes than the male of that species, being only the size of those of its female (this character also distinguishes it from the description of *B. megalops*). In my table(16) it would be associated with *B. mastersi* and *B. pictus*, but is is much smaller and otherwise different from those species. The head and prothorax have a somewhat redder tone than the other pale parts; the pale portion of the elytra occupies hardly more than the slope adjacent to the prothorax.

CARPHURUS ARMIPENNIS, Fairm.

A male of this species, from Port Denison, has a wide space along the suture pale, and an obscurely pale latero-apical spot.

CARPHURUS PALLIDIFRONS, Lea.

A female, from Aspendale (Victoria), in Dr. Ferguson's collection, has the front tibiae and the tips of all the femora flavous. A male, from the Victorian Alps, in the National Museum, probably belongs to the species, but has a conspicuous curved red mark connecting the eyes.

CARPHURUS LONGICOLLIS, Lea.

A male, from Cairns, has the abdomen and tibiae entirely reddish.

CARPHURUS FRENCHI, Lea.

A female, from the Blue Mountains, in Dr. Ferguson's collection, has the pale basal markings of the elytra larger than usual, and the prothorax with an irregular, infuscate blotch.

CARPHURUS PUNCTATUS, Lea.

A specimen, from Launceston, has the prothorax with a large black spot on each side, much as on some varieties of *C. elongatus*, but the two species are otherwise very distinct.

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(16) Lea, Trans. Ent. Soc. Lond., 1909, p. 180.

CARPHURUS INVENUSTUS, Lea.

A male, from Illawarra, has parts of the elytra obscurely diluted with red.

CARPHURUS ALTERNIVENTRIS, Fairm.

Two females, from Cairns, in Dr. Ferguson's collection, have the legs almost entirely black and the head black, with an almost round, red spot, half-way between the base and apex. A male, from Gayndah, has a pale vitta on the side of each elytron, from the base to near the middle, touching the side at the base, but not at the middle; a female mounted with it (and a similar one from Cairns) has the vitta reduced to an isolated spot near the side, its head has a large circular red space, rendered rather conspicuous by the adjacent surface being infuscated.

CARPHURUS CRISTATIFRONS, Fairm.

A female, from Mount Tambourine, has a longitudinal black spot on the disc of the pronotum.

CARPHURUS ELONGATUS, Macl.

Of two males, from Aspendale (Victoria), in Dr. Ferguson's collection, one has the apical three-fifths of elytra black, except that the inner angle of each is obscurely diluted with red; its prothoracic spots are normal; the other has the prothorax immaculate, and the inner angles of the elvtra no paler than the adjacent parts.

CARPHURUS GALLINACEUS, n. sp.

♂. Flavous; abdomen reddish-flavous; base of head, scutellum, mesosternum, metasternum, and coxae black; seven apical joints of antennae infuscated or black; labrum slightly infuscated. With sparse and very short pubescence in parts, and with long, straggling, dark hairs.

Head with a wide, semidouble excavation between eyes, and a smaller (but large one) on each side, each of the latter bounded inwards by a strong, curved elevation, the two elevations connected in front; base punctate and transversely strigose. Antennae moderately long, third to ninth joints serrated. *Prothorax* slightly longer than greatest width (near apex), sides evenly rounded, a wide shallow depression near base, and a shallower one near apex. *Elytra* about twice the length of prothorax and much wider than its base, each side near apex with a conspicuous notch, the margins of the notch thickened, its anterior end obtusely pointed, the posterior end armed with a flat, acute spine, directed forwards and outwards, each elytron near apex outwardly curved at suture; with dense and rather small, but sharply defined punctures. Basal joint of front *tarsi* with a small, black, inner comb. Length, 5 mm.

Hab.—Queensland: Bribie Island (A. M. Lea). Type (unique), I. 11941.

The crest on the head is even larger than on *C. cristatifrons*, and the ridges composing it curve round at the base, with the excavation behind them bisinuate, instead of single; the excavation at the side of each eye terminates before the posterior end of the eye, in *cristatifrons* (as viewed from the side) it is seen to slightly pass the eye; on the present species also there is a slight infuscation on each elytron near the suture, but the derm near the armature is immaculate.

CARPHURUS EXCISUS, n. sp.

♂. Black; head, except at base, prothorax, elytra about armature and on extreme sides, thence to base, but not to apex, tips and sides of abdominal segments, three basal joints of antennae, and parts of tibiae reddish-flavous With long, dark hairs, and in parts with sparse, white pubescence.

Head with three rather large excavations: one in middle bounded on each side by a narrow ridge, and one on each side bounded by an eye; with irregularly distributed punctures, base transversely strigose. Antennae moderately long, third to tenth joints moderately serrated. *Prothorax* slightly longer than the greatest width (near middle), sides evenly rounded, a wide shallow depression near base; with a few scattered punctures. *Elytra* about twice the length of prothorax, each side near apex strongly notched, the part bounding the notch strongly thickened, its posterior end with a flat blunt-tipped process, directed outwards and forwards; with dense and rather sharply defined punctures, except on tips, which are strongly, separately rounded. Basal joint of front *tarsi* with a small, black, inner comb. Length, 4·25 mm.

Hab.—Victoria: Fern Tree Gully (F. E. Wilson). Type (unique), I. 11942.

Structurally close to *C. gallinaceus*, but crest of the head with its sides less distant at base, the excavation behind it not bisinuate, and the elytra, abdomen, and legs very differently coloured. The sculpture in general is near that of *C. cristatifrons*, but the inner part of the crest is different, and the elytra, etc., are differently coloured.

CARPHURUS BALTEATUS, n. sp.

♂. Flavous; elytra blackish, with a wide flavous fascia near base, and with an obtuse extension along suture, apical half or more of antennae and metasternum infuscated or black. With rather long, dark hairs, elytra with short, whitish pubescence.

Head with a large excavation between eyes, in its middle a ridge crowned by a golden fascicle diverging to each side; in front of the excavation a slightly hairy ridge, interrupted in middle, a large and rather shallow depression in front; with irregularly distributed punctures, base densely transversely strigose. Antennae moderately long, most of the joints serrated. *Prothorax* slightly longer than the greatest width, a wide shallow depression near base; with a few scattered punctures. *Elytra* about twice the length of prothorax, each side at basal third with an obtusely triangular projection; with dense and sharply defined punctures, becoming sparser on tips. Basal joint of front *tarsi* with a small, black, inner comb. Length, 6-7 mm.

Hab.—Northern Territory: Darwin (N. Davies and F. P. Dodd). Type, I. 11940.

The head when viewed from behind appears to have two tubercles, but these are less distinct than on *C. purpureipennis*, and the ridges giving rise to them are differently placed, the median fascicles are not black, as on *C. fasciculatus* and *C. uncinatus*, which also have the head differently sculptured. The head, when viewed from certain directions, appears to have a ridge from each side, not quite meeting in the middle, the point where they would have joined being overhung by the fascicles; in the male of *C. armipennis* the lateral ridges meet at the central one, which is not fasciculate in front, but some varieties of that species have a large part of the base of elytra pale. On one of the specimens the abdomen is entirely pale, and of a more reddish tone than the other, some of whose basal segments are slightly infuscated.

CARPHURUS MICROPTERUS, n. sp.

♂. Black, elytra and legs piceous-black. With sparse, whitish pubescence, and long, straggling, dark hairs.

Head wide; with dense and moderately coarse punctures. Antennae not very long, basal joint rather large and swollen at apex, second subglobular, third to ninth about as long as second, but becoming acutely triangular on one side, tenth and eleventh narrower, the eleventh scarcely longer than tenth. *Prothorax* distinctly transverse, sides rather strongly rounded, a narrowly impressed subbasal line; with numerous sharply defined, but not very large punctures. *Elytra* short, strongly narrowed posteriorly; with fairly dense asperate punctures. Tip of *abdomen* with a wide process on each side. Basal joint of front *tarsi* with a small comb on inner edge. Length, 3 mm.

Hab.—South Australia: Adelaide (Blackburn's collection). Type (unique), I. 11946.

A curious species that in some respects seems nearer *Helcogaster* than *Carphurus*, and for which possibly a new genus should have been proposed, the elytra are shorter than in any other species of the allied genera, being shorter than the head and prothorax combined, and shorter than their own basal width; the tip of the abdomen also is peculiar, in addition to the process on each side there is a pointed median one on the type (probably the tip of an oedeagus); most of the antennal joints have numerous rather long hairs.

CARPHURUS CRIBRATUS, n. sp.

♂. Black, front half of head, four basal joints of antennae, prothorax (except for a wide subapical fascia), basal two-fifths of elytra, tips and sides of subapical segment of abdomen distinctly, and of some of the others inconspicuously flavous; tibiae and most of tarsi flavous, or testaceo-flavous. With sparse, whitish pubescence, and long, dark hairs

Head with small tubercles and depressions on front half; with small, dense punctures. Antennae rather long and thin. *Prothorax* about as long as the greatest width (near apex), an inconspicuous depression across base; with dense punctures, in places transversely confluent. *Elytra* more than twice the length of prothorax; with dense and sharply defined punctures, but some of them confluent. Basal joint of front *tarsi* with a black comb at inner apex. Length (♂, ♀), 3-3·5 mm.

♀. Differs in having the head smaller, less uneven, and with more distinct punctures in front, eyes smaller, antennae shorter, abdomen much wider, and front tarsi combless.

Hab.—Queensland: Bundaberg (Blackburn's collection). Type, I. 11948.

In my table (17) would be associated with *C. elongatus*, from which it differs in its coarser elytral punctures and sculpture of head. The fine pubescence on the prothorax, from some directions, causes the punctures to appear like strigae. On the male there is a scarcely traceable infuscation about the scutellum, but on the female it is more pronounced; the black prothoracic fascia is nearer the apex than base, but it varies in extent on the three specimens before me.

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(17) Lea, Trans. Ent. Soc. Lond., 1909, p. 188.

CARPHURUS INTEROCULARIS, n. sp.

♂. Flavous; elytra dark metallic-green; scutellum, metasternum, a basal portion of each segment of abdomen except the apical one (which is entirely pale), and hind trochanters black. With rather sparse, dark hairs, and in parts with sparse, whitish pubescence.

Head large; with a wide and deep inter-ocular excavation, its posterior end curved; a conspicuous inter-antennary tubercle projecting triangularly backwards into the middle of its anterior end; a deep oblique impression on each side close behind it; punctures irregularly distributed. Antennae long and rather thin, scarcely serrated, none of the joints transverse. *Prothorax* distinctly transverse, sides and base strongly rounded; with a few scattered punctures. *Elytra* more than twice the length of prothorax; with dense and, for the genus, rather large punctures, in places confluent. Basal joint of front *tarsi* lopsided, a black inner comb from base to apex. Length, 5 mm.

Hab.—South Australia. Type (unique), I. 11943.

In general appearance close to *C. cyaneipennis*, and with entirely pale antennae (the four basal joints are paler than the others, but these are not infuscated), but basal joint much thinner than on the male of that species, and the head strongly sculptured; its sculpture at once distinguishes the species from the males of *C. telephoroides*, *C. latipennis*, *C. cervicalis*, and other similarly coloured species. In my table it would be associated with *C. basiventris*, which has partly dark antennae and legs, differently coloured elytra, etc.

CARPHURUS TRICOLOR, n. sp.

♂. Black; head, four basal joints of antennae (except upper-surface of first), prothorax, and front femora flavous; elytra deep blue. With very sparse, pale pubescence, and moderately long, dark hairs.

Head with a somewhat circular depression, in the middle of which is a slight elevation; with rather dense and distinct punctures, the base transversely strigose. Antennae rather long and thin, only the second joint transverse. *Prothorax* longer than wide, base much narrower than apex, a wide depression near base; sides with dense punctures, sparse elsewhere. *Elytra* more than twice the length of prothorax; with dense and sharply defined punctures, even at apex. Length, 4-4·25 mm.

Hab.—Queensland: Cairns district (A. M. Lea). Type, I. 11945.

A beautiful little species; the type has the front femora pale, so in my table would be associated with *C. facialis*, from which it differs in the sharply defined punctures of elytra and in many details of colour, in particular the blue elytra and red head; regarding a second specimen (having somewhat infuscated front femora) as having entirely dark legs, it might be associated with *C. pallidifrons* (although the elytra are not metallic), from which it differs in its entirely pale head, sharper elytral punctures, etc. From the description of *C. azureipennis* it differs in the entirely black abdomen, black scutellum, front legs partly pale, and pale basal joints of antennae.

CARPHURUS SEMIRUFUS, n. sp.

♀. Black; head (except for a vague infuscation behind each eye), four basal joints of antennae, prothorax, tibiae, and tarsi reddish. With long, dark hairs, and sparse, pale pubescence.

Head gently convex between eyes, a shallow transverse impression in front; with minute punctures, becoming larger near eyes, base transversely strigose. Antennae moderately long, third to tenth joints rather strongly serrated, eleventh almost twice the length of tenth *Prothorax* slightly transverse, sides strongly rounded, apex slightly wider than base; with a few scattered punctures. *Elytra* short, scarcely twice the length of prothorax; with fairly dense and rather sharply defined, but small punctures, becoming still smaller posteriorly. Length, 4 mm.

Hab —Northern Territory: Melville Island (G. F. Hill, No. 351) Type (unique), I. 12201.

At first glance the type appears to be a *Helcogaster*, but the sharply defined elytral punctures, and serrations of antennae, should exclude it from that genus. Regarding the species as belonging to G of my table of *Carphurus*, it would be associated with *C. triimpressus*, which, with others of G, have been transferred to *Balanophorus* (the type has combless front tarsi so cannot belong to that genus); but regarding it as belonging to GG, it would go with *C. facialis*, which has elytra longer, more metallic, and with larger punctures, part of head black, etc.; the elytra are shorter and with less conspicuous punctures than in *C. basiventris*, the head is wider, and abdomen entirely black.

CARPHURUS COMPSUS, n. sp.

♂. Flavous; six apical joints of antennae and part of the preceding one, and a large blotch on elytra blackish. With fairly numerous dark hairs, and in places with very sparse, ashen pubescence.

Head moderately long, gently convex between eyes, a rather large shallow depression in front; with fairly distinct but irregularly distributed punctures, base transversely strigose. Antennae rather long, third to tenth joints strongly serrated, eleventh distinctly longer than tenth. *Prothorax* distinctly longer than wide, sides from near apex narrowed to base, a wide shallow depression near base; punctures sparsely distributed. *Elytra* more than twice the length of prothorax; with dense, small, and mostly rugulose punctures. Basal joint of front *tarsi* lopsided, with a narrow, black, inner comb. Length, 6 mm.

Hab.—Northern Queensland (Blackburn's collection). Type, I. 11952.

The dark blotch on the elytra is sharply defined, it commences on each elytron at the basal third, from the suture it is directed obliquely towards the shoulder for a short distance, is then directed backwards to slightly beyond the middle, and from there straight to the side, the derm thence being entirely dark. At first glance it looks like some of the varieties of *C. longus*, but the antennae are strongly serrated; the male of *C. elegans* has the basal joint of the front tarsi more than twice as long as in this species, abdomen tipped with black, etc.

A female, from Cairns (A. M. Lea), that possibly belongs to this species, differs from the type in having the head smaller, with two feeble depressions in front, antennae shorter, thinner, feebly serrated and entirely pale, elytra with the dark portion more diffused, and covering rather more than the apical half as an infuscation, with more sharply defined punctures, and legs shorter, with front tarsi combless.

CARPHURUS MACROPS, n. sp.

♂. Flavous; five apical joints of antennae, apical half of elytra, and most of abdomen infuscated. With straggling, dark hairs, and sparse, ashen pubescence.

Head gently convex between eyes, a feeble depression each side in front; with rather sparse punctures, becoming denser behind eyes, but base transversely confluent. Eyes large and prominent. Antennae rather long, third to tenth joints strongly serrated, eleventh about once and one-half the length of tenth. *Prothorax* longer than wide, sides diminishing from near apex to base, a wide shallow depression near base; a few punctures scattered about. *Elytra* scarcely twice the length of prothorax; with dense and small, but fairly sharply defined punctures. Basal joint of front *tarsi* with a narrow, black, inner comb, from base to apex. Length (♂, ♀), 4-4·5 mm.

♀. Differs in having the head smaller, with smaller (but still large) eyes, antennae shorter and thinner, and legs shorter, with simple tarsi

Hab.—Queensland: Cairns district (A M. Lea). Type, I. 11950.

The dark part of the elytra, although distinct, is not very sharply limited; on the two females taken, but not on the male, it is narrowly continued along the sides to the base, on one female the abdomen is entirely pale. In the male the combined width of the eyes is rather more than the space between them, in the female it is about three-fourths of that space: their length is slightly more than that of the two basal joints of antennae; they are as large as in *C. vigilans*, but the head is very differently sculptured. The antennae are rather strongly serrated, and so the species might be referred to G of my table, and there associated with the pale-headed form of *C. lepidus*, from which it differs in its much larger eyes, less defined elytral punctures, etc., referring it to GG it would be associated with *C. atricapillis*, which is a considerably larger species, with very different antennae.

CARPHURUS LATUS, n. sp.

♂. Flavous: elytra deep purple, except at base and for a short distance along suture; eight apical joints of antennae, metasternum, parts of both surfaces of three basal segments of abdomen, middle coxae and femora, and most of hind legs, black or blackish. With long, straggling, blackish hairs, and sparse, ashen pubescence.

Head wide, somewhat uneven in front; with dense punctures near eyes. Antennae rather short and stout, third to tenth joints strongly serrated. *Prothorax* slightly longer than its greatest width (across apical third), a wide shallow depression near base; with small and very sparse punctures. *Elytra* about twice the length of prothorax, wide at base, sides suddenly dilated before the middle, and then feebly narrowed to apex; with fairly dense but uneven punctures. Basal joint of front *tarsi* lopsided, but not very large, with a small, black comb on inner edge. Length, 6·5 mm.

Hab.—North-western Australia: Wyndham, in March (J. Clark from W. Crawshaw). Type (unique), I. 11951.

An unusually wide species, at first glance appearing to belong to *Helcogaster*; but the elytra with distinct punctures, head not largely excavated and antennae serrate, are evidence that it should be referred to *Carphurus*; the appendix to each claw is larger than is usual in the allied genera. The eyes are large, and, when viewed from the side, appear to have no part of the head above them. The elytral punctures are often sharply defined, but are mostly rugose, some of them are so shallow as to be scarcely traceable, especially about the tips. The antennae are not subpectinate, so regarding the species as belonging to GG of my table it would be associated with *C. atricapillus*, from which it differs in most details of shape; if it were referred to *Helcogaster*, it would be associated with *H. punctipennis*, with which it has also few details in common.

NEOCARPHURUS COSTIPENNIS, n. sp

♀. Black; antennae, except some of the apical joints, and extreme base of prothorax flavous. A few dark hairs scattered about.

Head opaque and with rather dense punctures, a shallow depression each side in front, and a shallow median line. Antennae moderately long, none of the joints transverse. *Prothorax* slightly longer than greatest width, which is at apex, sides rounded and strongly narrowed to near base, and then almost parallel to base, which is feebly bilobed, a deep, transverse, open depression near base. *Elytra* almost twice the length of prothorax, and twice as wide as its base, opaque and shagreened except about base, a fine costa extending obliquely inwards from each shoulder. Length, 2·5-2·75 mm.

Hab.—Northern Queensland (Blackburn's collection), Cairns (Dr. E. W. Ferguson). Type, I. 10948.

The opacity of the elytra appears to be due principally to very minute pubescence, but the species may be readily known from *N. pilosipennis*, *N. angustibasis*, and all others of the genus, by the costa running inwards from each shoulder for about one-third the length of the elytron. On the type the three apical joints of the antennae, and the upper-surface of the first, are infuscated; on a second specimen only the two apical joints are infuscated.

NEOCARPHURUS SEMIFLAVUS, n. sp.

Flavous; metasternum and abdomen black; apical three-fifths of elytra, parts of hind legs, of middle and of front tibiae and tarsi, and two apical joints of antennae, more or less deeply infuscated. With a few straggling hairs.

Head with a wide depression between eyes, and a large, obtuse, inter-antennary tubercle. Antennae moderately long, second to sixth joints transverse, eleventh longer than tenth. *Prothorax* longer than wide, sides rounded and strongly narrowed to near base, and then subparallel to base, which is feebly bilobed and about half the width of apex. *Elytra* about once and one-half the length of prothorax, and much wider than its base, the dark part opaque and very minutely pubescent. Front *tarsi* rather short, basal joint with an inner black comb. Length, 3 mm.

Hab.—New South Wales · Rydalmere (Dr. E. W Ferguson). Type (unique), I. 11955.

The dark part of the elytra is opaque; on *N. coatesi* and *N. impunctatus* it is just as highly polished as the pale part. The eyes of the type are still of a vivid green.

HELCOGASTER.

A table of this genus, containing less than half of the now known species, was given in the 1909 revision of the family,(18) but the features by which the species are distinguished are so often on the head, and do not lend themselves readily to be condensed into brief tabular characters, that a grouping is now given, and only males are included, as it appears to be impossible to identify many of the females with certainty from descriptions. Some of the species, with the head comparatively simple in the male, might be regarded as belonging to *Carphurus*, but all such doubtful species have very minute rugulose punctures on the elytra, and the antennae feebly serrated at most. An asterisk (*) denotes that the species has been placed in its group by the published characters:—

1. Antennae with basal joints distinctive.

FOVEICORNIS, Lea
INSIGNICORNIS, Lea

2. Prothorax not simple near, or at, apex.

CAVICEPS, Lea
IMPERATOR, Lea
INCISICOLLIS, Lea
MEDIOAPICALIS, Lea
NIGRIVENTRIS, Lea
SPINICOLLIS, Lea

3. Basal joints of antennae not distinctive, and prothorax simple near, and at, apex.

A. Prothorax partly or entirely dark.

a. Elytra entirely dark.

ATER, Lea
ATERRIMUS, Lea
BASIRUFUS, Lea
CANALICULATUS, Lea
CAPSULIFER, Lea
COELOCEPHALUS, Lea
EFFEMINATUS, Lea
EXCAVIFRONS, Lea
GAGATINUS, Lea
GENICULATUS, Lea
HOPLOCEPHALUS, Lea
LITORALIS, Lea
MELAS, Lea
NIGER, Lea (typical)
OBLIQUICEPS, Lea
PARALLELUS, Lea
PULCHRIPES, Lea (variety)
PUNCTICEPS, Lea
RUFICORNIS, Lea
TRIANGULIFER, Lea (typical)

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(18) Lea, Trans. Ent. Soc. Lond., 1909, p. 215.

b. Elytra not entirely dark.

BASICOLLIS, Lea
BREVICORNIS, Lea
CRIBRICEPS, Lea
FASCIATUS, Lea (Note 1)
FLAVIPENNIS, Lea
INFLATUS, Lea
LATEROFUSCUS, Lea
MACULICEPS, Lea (variety)
MARGINICOLLIS, Lea
MEDIOFLAVUS, Lea
OPACICEPS, Lea

B. Prothorax entirely pale.

c. Elytra entirely dark.

APICICORNIS, Lea
ATRICEPS, Lea
BRACHYPTERUS, Bohem.
CARINATICEPS, Lea
CENTRALIS, Lea
CERATICEPS, Lea
CONCAVICEPS, Lea
DECIPIENS, Lea
FOVEICEPS, Lea (Note 2)
HACKERI, Lea
HELMSI, Lea
INSULARIS, Lea
MACROCEPHALUS, Lea
MAJOR, Lea
NIGER, Lea (variety)
*NIGRICEPS, Lea
OXYTELOIDES, Lea
PULCHRIPES, Lea (typical)
STRIGICEPS, Lea
TRIANGULIFER, Lea (variety)
TROPICUS, Lea
T. TUBERCULATUS, Lea
VARIUS NIGRIPENNIS, Lea
VENTRALIS, Lea

d. Elytra not entirely dark.

BACCHANALIS, Lea
BILOBUS, Lea
CONVEXICEPS, Lea
FUSCITARSIS, Lea (Note 3)
HUMERALIS, Lea
*IMPRESSIFRONS, Bohem.
LATICEPS, Lea
MACULICEPS, Lea (typical)
PALLIDUS, Lea
PIGNERATOR, Lea (Note 4)
PUNCTILOBUS, Lea
PUNCTIPENNIS, Lea
RHYTICEPHALUS, Lea
SEMINIGRIPENNIS, Lea
SIMPLICICEPS, Lea
SULCICEPS, Lea
THORACICUS, Lea
TRIFOVEICEPS, Lea
TRISINUATUS, Lea
TUBERCULIFRONS, Lea
VARIUS, Lea (typical)
VARIUS FLAVOPICTUS, Lea
VARIUS PALLIDIPENNIS, Lea

Note 1. The dark part of the prothorax of the type is possibly due to staining.

Note 2. On some males the sides of the prothorax have infuscated spots.

Note 3. The shoulders are not always conspicuously pale.

Note 4. The elytra of the type, from above, appear to be entirely dark.

Three species at present standing in *Carphurus* may eventually be transferred to *Helcogaster;* if so, their positions would be as follows:—*C. atronitens* in *a*, *C. basipennis* and *C. fasciipennis* in *d*.

HELCOGASTER GAGATINUS, Lea.

A female, from Melville Island, probably belongs to this species, but has the front femora black with a pale vitta, as on some males from New South Wales

HELCOGASTER INSULARIS, Lea.

A male, from the Dividing Range (Victoria), has the projection between the basal sinuations of the head clothed with rusty red hair, resembling a short fascicle, on the types the hair there is black, and so hardly conspicuous.

HELCOGASTER PULCHRIPES, Lea.

A male, from Mount Lofty, differs from the type of this species in having all the legs, except the tarsi and coxae, reddish, only the extreme tip of antennae infuscated, and the prothorax with a conspicuous blackish spot on each side.

HELCOGASTER TUBERCULIFRONS, Lea.

On the male of this species the basal half of the head is usually deeply infuscated; on the females the infuscation of the head is more pronounced, the tubercle is reduced to a slight swelling on each side of the front of which is a shallow impression, the antennae are thinner, and the front tarsi are simple Two females, from Dorrigo, sent with several typical ones, are rather larger than the others, and have the head deep black and highly polished, with only the lateral parts of the muzzle pale; a similar female, from the Tweed River, is in Mr. H. J. Carter's collection.

HELCOGASTER TROPICUS, Lea.

From some directions the wide median excavation on the head of the male, of this species, seems to be bounded near each eye by a subconical tubercle. The female differs from the male in having the head almost entirely black, without a large excavation, but shallowly bifoveate in front, the neck less strongly narrowed, and the basal joint of the front tarsi combless. On both sexes the legs, except for the knees, are usually entirely black.

The typical specimens were labelled, in the Macleay Museum, as from Cairns, but probably in error, as I have seen no other specimens of the species from Queensland, and it is abundant in the Mount Lofty Ranges, near Adelaide.

HELCOGASTER NIGER, Lea.

This species occurs in abundance in South Australia (Port Lincoln, Tumby Bay, Kangaroo Island, Adelaide, Mount

Lofty, Lucindale, and Mount Gambier). The head of the male, viewed from behind, appears to have three small median tubercles and a slightly larger one near each eye.⁽19⁾ The typical, but not the commonest, form of the male is black, except that some of the basal joints of antennae and the knees are obscurely reddish or testaceous.

Var. 1, ♂. Prothorax with extreme base, and sometimes the sides near base, more or less reddish.

Var. 2, ♂. Prothorax with sides (or a vitta near each side) of prothorax pale, but not to apex, the pale portion usually not continued across middle of base. On some specimens of this form there is also a short, obscure, medio-apical vitta.

Var. 3, ♂. Prothorax with dark markings reduced to a median infuscated spot (usually rather large), and generally with infuscated stains about apex, or sides. On many specimens of this variety the large spot is obscurely connected with two small apical spots, so as to resemble an irregular Y. or the Y may be sharply defined.

The varieties run into each other, but I have seen only one in which the prothorax is entirely pale. In the commonest form of the female the base and sides near base of the prothorax are pale, but the various forms have not been described, as many of them are scarcely distinguishable from females of other species, although the males, by the sculpture of the head, are abundantly distinct.

HELCOGASTER T-TUBERCULATUS, Lea.

In the table⁽20⁾ this was in error referred to as *tuberculatus.*

HELCOGASTER IMPERATOR, n. sp.

♂. Black; front half of head, prothorax, a large subtriangular portion at base of elytra (an infuscate blotch about scutellum excepted), and parts of legs and of antennae flavous, or reddish-flavous. With a few scattered dark hairs.

Head wide, with a rather shallow longitudinal impression each side in front. Antennae rather stout, second to tenth joints more or less transverse, eleventh slightly longer than wide. *Prothorax* considerably wider than long, widest close to apex, a deep transverse excavation near apex, and a shallow one near base. *Elytra* not much longer than wide, each separately rounded at apex; with sparse and inconspicuous, rugulose punctures. Basal joint of front *tarsi* with a distinct black comb. Length (♂, ♀), 2·5-4 mm.

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(19) Lea, Trans. Ent. Soc. Lond., 1909, pl. ii., fig. 9.

(20) *L.c.*, p. 216.

♀. Differs in having the head, except the labrum, entirely black, front femora, as well as the others, partly dark, antennae longer and thinner, none of the joints transverse, prothorax only slightly wider than long, apex very little wider than base, non-excavated or tuberculate, and front tarsi combless.

Hab.—South Australia: Adelaide (Blackburn's collection, H. H. D. Griffith, J. G. O Tepper, N. B. Tindale, and A. Zietz), Mount Lofty (R. J. Burton, S. H. Curnow, A. H. Elston, A. M. Lea, and Tepper), Barossa (Elston), Quorn (Blackburn), Noarlunga (Burton). Type, I. 9185.

Some females were named as *H. basipennis* (Fairmaire) in Blackburn's collection, and in many respects they agree well with the description of that species; but it was described as from Peak Downs in Queensland, and there are so many other species from Queensland and New South Wales that the description would fit equally well, that I think this species (all the specimens of which before me are from South Australia) should not be regarded as *basipennis*; in any case the male of the present species has such a distinctive prothorax that it could hardly be confused with the male of any other species. The excavation of its prothorax varies somewhat, but it is always deep and wide, it is nearly always bounded at each end by a subconical tubercle, its front edge is often impressed in the middle, and has a feeble elevation on each side of the impression, and as all the elevations are setose the front margin, from some directions, appears quadrituberculate; the bottom of the excavation is usually infuscated or black The impressions on the head of the male are so placed that from some directions the intervening space (appearing as a wide gentle elevation), and the lateral elevations, resemble the broad arrow. From three to five joints of his antennae are pale, on one specimen they are entirely pale; the hind femora are partly black or infuscated, and sometimes the middle ones as well; the apical joints of all the tarsi are infuscated. The true width of the elytra is very little less than that of the length, but owing to irregular contraction it often appears to be much less.

HELCOGASTER MEDIOAPICALIS, n. sp.

♂. Black and highly polished; prothorax (except middle of apex), front coxae and femora, and base of middle femora flavous. With very sparse, dark hairs.

Head wide, largely and irregularly excavated. Antennae moderately long, joints gradually decreasing in width, eleventh about once and one-half the length of tenth. *Prothorax* about as long as its greatest width, sides almost evenly rounded, middle of apex irregular. *Elytra* dilated from near base, each separately rounded at apex; with fairly numerous and small, but (for the genus) rather distinct, rugulose punctures. *Legs* rather long and thin, basal joint of front tarsi large, lopsided, and with a comb on the inner edge. Length, 3·5 mm.

Hab.—New South Wales: Blue Mountains (Blackburn's collection). Type (unique), I. 11915.

The prothorax not simple at apex associates this species in my table with *H. incisicollis* and *H. spinicollis;* the former has the prothorax black and deeply notched, the latter has the apex spined; on the present species there is a curved impression across the median apex, behind which the surface is elevated, and from some directions appears to project slightly forwards, but it is not spinose; the irregular part is darker than the rest of the prothorax; the general appearance and elytra are much as in *H. concaviceps*. The excavation on the head is transverse, and continuous from eye to eye, its hind margin is obtusely trisinuate, and front margin more sharply so, and it has a small tubercle in its middle not elevated above the level of the eyes; from some directions it appears to have several small tubercles. On the type the front tibiae and tarsi are infuscated, so that the tarsal comb (which on the males of most species show up as a distinct black inner rim) is inconspicuous, but under the microscope it is seen to be composed of about thirty long, close-set teeth.

HELCOGASTER LITORALIS, n. sp.

♂. Black: head (except base), most of prothorax, and basal third of antennae reddish-flavous. With sparse, dark hairs, elytra glabrous or almost so.

Head shallowly impressed on each side in front, towards base with a wide triangular elevation. Antennae moderately long, second to fifth joints slightly transverse, sixth to tenth slightly longer, eleventh longer than tenth. *Prothorax* slightly longer than wide, widest near apex, with a closed depression near base. *Elytra* moderately long; with sparse, inconspicuous punctures. Basal joint of front *tarsi* lopsided, and with an inner comb. Length (♂, ♀), 2·25-3 mm.

♀. Differs in having the head black almost to the muzzle, and without the triangular elevation, prothorax almost or entirely black, antennae somewhat thinner, and front tarsi combless.

Hab.—Lord Howe Island (A. M. Lea). Type, I. 11906.

In my table would be associated with *H. obliquiceps*, which has a very different head, in fact the head is very different from that of any other species; seen from behind its entire base appears to be triangularly elevated; it is transversely impressed at the extreme base, with the triangle overhanging it; even on the female there are traces of these. Twelve specimens were obtained on the island by the use of a sweep-net on grasses, etc., close to a beach; of these four are males, and the dark parts of the prothorax on each appear to be more of the nature of stains than regular markings, on three of them there is an irregular postmedian fascia, on the fourth there is only a small spot on each side; but the prothorax of the female is deep black, with the base usually, but not always, more or less reddish. On several specimens of each sex the knees are obscurely reddish.

HELCOGASTER MEDIOFLAVUS, n. sp.

♂. Black; middle portion of elytra obscurely pale flavous, three or four basal joints of antennae more or less flavous. A few blackish hairs scattered about.

Head with a rather shallow, inter-ocular impression; with three distinct costae in front, the median one shorter than the others. Antennae longer (passing elytra) and more distinctly serrated than usual in genus. *Prothorax* slightly transverse, sides evenly rounded, a wide transverse depression near base. *Elytra* moderately long, inconspicuously rugulose. *Abdomen* with a small medio-apical process. Basal joint of front *tarsi* lopsided, with an inner comb. Length, 2-2·5 mm.

Hab.—South Australia: Quorn (A. H. Elston), Murray Bridge (A. M. Lea). Type, I. 11899.

The bicoloured elytra and tricostate head render this species a very distinct one, and at once distinguish it from *H. obliquiceps* and *H. gagatinus*, with which it would be associated in my table. The dark parts of the elytra are a wide basal triangle, and the apical two-fifths, the pale intervening portion is distinct, but its outlines are not sharply defined. A specimen from the old collection, without exact locality, has the dark parts more brown than black, with the pale portion of the elytra more extended. There are five males before me, but I have been unable to associate any females with them.

HELCOGASTER OPACICEPS, n. sp.

♂. Black; elytra with median portion pale flavous, three basal joints of antennae, knees, front tibiae, and tarsi, more or less reddish-flavous. A few blackish hairs scattered about.

Head wide, opaque and densely punctate, a fairly large depression close to each eye, the two separated by an obtuse, shining ridge. Antennae moderately long and feebly serrated. *Prothorax* slightly transverse, sides evenly rounded, a wide transverse impression at base; a few punctures on sides. *Elytra* moderately long; with a few small, rugulose punctures. Basal joint of front *tarsi* lopsided, with a black inner comb. Length (♂, ♀), 2·75-3·25 mm.

♀. Differs in having the head narrower, the median ridge and lateral depressions much less distinct, antennae somewhat shorter and thinner, prothorax more transverse, and front tarsi combless.

Hab.—South Australia: Quorn (E. L. Savage), Tarcoola and Ooldea (A. M. Lea). Type, I. 12212.

Colours much as in the preceding species, from which it differs in being slightly wider, head opaque (except in front) and with dense punctures, instead of highly polished, and antennae somewhat shorter. On the only male before me the dark parts of the elytra are a large basal triangle, and the apical two-fifths; on one of the females the dark basal portion is extended, and the apical portion decreased; on the other female the dark parts are both somewhat extended and narrowly meet on the suture.

HELCOGASTER CRIBRICEPS, n. sp.

♂. Black; median portion of elytra flavous, four basal joints of antennae, tibiae and tarsi more or less reddish-flavous. With sparse dark hairs.

Head rather wide; with small and fairly dense, sharply defined punctures, becoming denser in front; a shallow depression on each side in front. Antennae fairly long, moderately stout, and obtusely serrated. *Prothorax* moderately transverse, sides gently rounded and narrower at base than at apex, base with a transverse depression. *Elytra* not very long, each separately rounded at apex; with fairly numerous small, but rather sharply defined, rugulose punctures. Basal joint of front *tarsi* with a small black comb. Length, 3 mm.

Hab.—Western Australia: Cue (H. W. Brown). Type (unique), I. 12121.

Close to *H. medioflavus*, and with similarly coloured elytra, but the head simple except for feeble lateral depressions and with, for the genus, very distinct punctures; these are sparser than on the preceding species, and are individually distinct, so that the head is shining, on that species they are so dense as to cause the head to be opaque. The pale portion of the elytra occupies rather more than the median third along the suture, it is somewhat extended on each side towards the base, but does not quite touch the sides, as a result, from above, the black basal portion of the elytra appears to be widely triangular.

HELCOGASTER BREVICORNIS, n. sp.

♂. Black; head in front of eyes, front sides of prothorax, elytra (a slight infuscation about scutellum), antennae, front legs, and knees, more or less flavous. A few dark hairs scattered about.

Head rather small, a wide, feeble, median elevation in front, a shallow depression on each side of it, and a more feeble one behind its middle; a few minute scattered punctures, but becoming dense behind eyes. Antennae short, scarcely reaching base of prothorax, all the joints, except first and eleventh, transverse. *Prothorax* moderately transverse, sides gently rounded, subbasal depression very feeble and ill-defined; a few small punctures scattered about, but becoming more condensed on sides. *Elytra* scarcely twice the length of prothorax; with a few small, rugulose punctures. Basal joint of front *tarsi* large, lopsided, and with a distinct, black, inner comb Length, 3·5 mm.

Hab.—Western Australia: Coolgardie (Blackburn's collection, from E. Meyrick). Type (unique), I. 11916.

The shallow depressions on the head are as on many females of the genus, and the head itself is rather small for a male, but the front tarsi are unmistakably masculine. On the type the base of the head is exposed and opaque, but it would probably be concealed on most specimens.

HELCOGASTER FLAVIPENNIS, n. sp.

♂. Black; labrum, elytra (a slight infuscation about scutellum), front legs and parts of the others more or less flavous. A few blackish hairs scattered about.

Head rather wide, a feeble trisinuate impression between eyes, a feeble and short median line; a few small punctures scattered about. Antennae thin and not very long *Prothorax* moderately transverse, sides evenly rounded, subbasal depression almost absent; almost impunctate *Elytra* rather short, dilated posteriorly; with sparse and minute, rugulose punctures. Basal joint of front *tarsi* large, lopsided, a distinct black comb from base to apex Length (♂, ♀), 2-3 mm.

♀. Differs in having the head smaller, median line less distinct, a shallow depression each side in front, antennae shorter, prothorax more transverse, and front tarsi combless.

Hab.—South Australia: Quorn (Blackburn's collection and A. H. Elston), Oodnadatta (Blackburn). Type, I. 11898.

In my table would be associated with *H. marginicollis*, which has cephalic armature and bicoloured prothorax; the almost simple head of the male, and pale elytra, except for a slight infuscation about scutellum, readily distinguish from *H. medioflavus;* in appearance it is much like the preceding species, but the head of the male is larger, more transverse, somewhat differently sculptured in front, less of muzzle pale, and pronotum entirely dark. The middle legs are sometimes almost entirely dark, sometimes only infuscated in parts; the hind ones usually have the base of femora obscurely pale; the antennae of the male are usually entirely pale; on the female the apical half, or more, is usually deeply infuscated; on several females the sides of the elytra are slightly infuscated posteriorly.

HELCOGASTER BASICOLLIS, n. sp.

♂ Black; base of prothorax, basal third of antennae and most of legs flavous; elytra obscurely piceo-flavous, blackish about base and suture. With sparse, black hairs.

Head smooth and almost impunctate between eyes, base and sides behind eyes densely punctate; two narrow and rather deep impressions in front. Antennae rather short. *Prothorax* moderately transverse, sides evenly rounded, base and apex subequal, subbasal depression scarcely traceable; a few punctures on sides. *Elytra* rather wide and not very long; with sparse, minute, rugulose punctures. Basal joint of front *tarsi* lopsided, a black comb on the inner edge. Length, 2·75-3 mm.

Hab.—South Australia: Quorn (A. H. Elston). Type, I. 11902.

Allied to the preceding species, but head more conspicuously bifoveate in front, prothorax pale at base, and elytra and legs more obscurely coloured. In my table it would be associated with *H. obliquiceps*, and *H. gagatinus;* the former has head very different and antennae longer; the latter is considerably narrower, with unicolorous prothorax. The head without large excavations and bifoveate in front, is as in many females of the genus, but the front tarsi are essentially masculine. On the two specimens taken by Mr. Elston the elytra from behind are seen to have the sides obscurely flavous, with the base and a fairly wide sutural space (narrowing posteriorly) blackish, but from above, or the sides, the two colours are not sharply defined. On both specimens parts of the tibiae and the hind femora are infuscated.

HELCOGASTER INFLATUS, n. sp.

♂. Black; apical three-fifths of elytra (more on sides), tibiae, and tarsi flavous. With very sparse, black hairs.

Head with a wide shallow depression in front, triangularly narrowed posteriorly and terminated level with hind edge of eyes; with minute scattered punctures, more numerous about eyes than elsewhere. Antennae rather short. *Prothorax* about as long as wide; a deep, transverse, subbasal depression, closed at each end. *Elytra* comparatively long, sides inflated in middle; punctures sparse, minute and rugulose. Basal joint of front *tarsi* slightly lopsided, with a small black comb. Length, 2 mm.

Hab.—South Australia: Port Lincoln (A. M. Lea). Type (unique), I. 11903.

The depression on the head, although from some directions appearing rather wide, could hardly be regarded as a large excavation, as it is rather shallow, and it is almost simple; hence in my table the species might be associated with *H. obliquiceps* and *H. gagatinus*. Regarding the head as largely excavated it would be associated with *H. marginicollis*. It is considerably narrower than *H. flavipennis*, impressions of head and prothorax different, elytra longer, and with more of its base dark; the dark portion has a somewhat rounded outline, and is rather sharply defined. The basal joints of antennae and base of prothorax are not as dark as the adjacent parts, but the different shades of colour are not at once apparent. The inflation of the sides of the elytra commences rather suddenly at the basal third.

HELCOGASTER MELAS, n. sp.

♂. Black; muzzle and three basal joints of antennae obscurely flavous. With sparse, dark hairs.

Head with a rather large, flattened elevation in front; with crowded punctures. Antennae moderately long. *Prothorax* moderately transverse, with a rather small subbasal depression. *Elytra* comparatively long; almost impunctate. Basal joint of front *tarsi* lopsided, with an inner comb. Length (♂, ♀), 2·25-3 mm.

♀. Differs in being without an elevation on head, its punctures more sharply defined in front, antennae somewhat shorter, and front tarsi combless.

Hab.—Victoria: Nelson (Blackburn's collection); South Australia: Lucindale (F. Secker). Type, I. 11895.

The elevation on the head is somewhat bottle-shaped, but the neck of the bottle is shorter than in *H. bacchanalis*, and the two species are otherwise very different. The head, when viewed from behind, appears to have a solitary median tubercle, but this is not as thin as in *H. parallelus*, and from above the head of that species is seen to be largely excavated;

on the present species there is a slight depression immediately behind the elevation. The elevation is somewhat suggestive of that of *H. litoralis*, on a greatly reduced scale, but the head otherwise, and the colours are different. In my table it would be associated with *H. obliquiceps*, which is a smaller species, with more of the head and legs pale, the head flatter between eyes, the elevation of different shape, and antennae much shorter.

HELCOGASTER PUNCTICEPS, n. sp.

♂. Black; muzzle and basal joints of antennae obscurely diluted with red. With sparse, dark hairs.

Head with a vague depression each side in front, leaving a feeble, impunctate, thin, parallel-sided elevation; elsewhere with dense punctures. Antennae rather long and thin. *Prothorax* lightly transverse, with a wide subbasal impression. *Elytra* moderately long; with small, rugulose punctures. Basal joint of front *tarsi* lopsided, with a small comb. Length, 2·25 mm.

Hab.—South Australia: Murray Bridge (A. M. Lea). Type (unique), I. 12122.

In some respects close to the preceding species, but head without a bottle-shaped elevation in front and antennae thinner; in my table it would be associated with *H. obliquiceps* and *H. gagatinus*, from which it differs in its darker head, with dense punctures; these are so dense that (except for the feeble elevation in front) the derm is rendered opaque.

Two females, from Adelaide, possibly belong to this species; they differ from the type in having the head smaller, with much sparser punctures, antennae shorter and thinner, base of prothorax obscurely reddish, and front tarsi combless.

HELCOGASTER CAPSULIFER, n. sp.

♂. Black; three or four basal joints of antennae obscurely reddish. With sparse, black hair.

Head with a flask-shaped elevation bounded by strongly impressed lines; with dense punctures, except on elevation. Antennae rather short and not very thin. *Prothorax* slightly wider than long, with a wide, closed subbasal depression. *Elytra* not very long; almost impunctate. Basal joint of front *tarsi* lopsided and rather large, with an inner comb. Length (♂, ♀), 3 mm.

♀. Differs in having head smaller, its elevation much smaller, entirely frontal, not flask-shaped, without deep bounding lines, punctures more evenly dense, antennae somewhat thinner, and front tarsi combless.

Hab.—New South Wales: Eden (H. J. Carter). Type, I. 11893.

The head has distinct impressions but it is not largely excavated, so in my table would be associated with *H. obliquiceps* and *H. gagatinus;* from which it is distinguished by the flask-shaped elevation, etc. On *H. melas* the elevation rises conspicuously above the general level of the head, on the present species it does not do this, being divided off by impressed lines, which become deep between the antennae; seen from in front, or obliquely from behind, there appears to be a deep, angular, interocular fovea, on each side of the apex of the flask; seen from directly behind there appear to be two minute tubercles near each eye.

A male from Tumby Bay, South Australia, in size, shape, colour, and sculpture of head so closely resembles the type that I think it must represent a variety of the species; its antennae are decidedly—about one-fourth—longer, and the head when viewed directly from behind does not appear to have two minute tubercles near each eye; the flask-shaped elevation, however, is of exactly the same shape.

HELCOGASTER EXCAVIFRONS, n. sp

♂. Black; two basal joints of antennae bright red. With a few inconspicuous dark hairs.

Head wide, with a large excavation; punctures small and crowded. Antennae moderately long. *Prothorax* slightly transverse, with a rather wide subbasal depression. *Elytra* rather short and wide; almost impunctate. Basal joint of front *tarsi* lopsided, and with an inner comb. Length (♂, ♀), 2·25-2·5 mm.

♀. Differs in having the head smaller, without excavation, punctures more uniformly distributed, antennae shorter, thinner, with the basal joints less brightly coloured, and front tarsi combless.

Hab.—South Australia: Port Lincoln, Tumby Bay (Blackburn's collection). Type, I. 11901.

The cephalic excavation is of irregular depth, its sides touch the front of the eyes, and its hind outline is a gentle curve, but with a slight median impression; the interantennary space is shining; viewed from behind the head appears to have two very small median elevations in front, but to be without one at the side of each eye. In my table it would be associated with *H. niger*, from which the excavation, single at its posterior end, is distinctive.

One of the four females, associated with the two males by Mr. Blackburn, has the base of the prothorax obscurely reddish.

HELCOGASTER ATERRIMUS, n. sp.

♂. Black; second and third joints of antennae and under-surface of first more or less reddish. With a few dark hairs.

Head wide, with a wide and deep excavation, its posterior end obtusely bilobed; behind the excavation with small and dense punctures. *Prothorax* near apex, slightly wider than long, with a rather wide, subbasal depression. *Elytra* moderately long; with numerous minute punctures. Basal joint of front *tarsi* lopsided, with an inner comb. Length (♂, ♀), 2-2·25 mm.

♀. Differs in having the head smaller, non-excavated, and with uniformly dense punctures, antennae shorter and thinner, and front tarsi simple.

Hab.—South Australia: Port Lincoln (A. M. Lea); Western Australia: Yilgarn (Blackburn's collection). Type, I. 11897.

At a glance apparently belonging to the preceding species, but excavation of head of different shape, although almost of the same size: when viewed from behind the head appears to have four small equi-distant conical elevations, the lateral ones slightly larger than the others, and one touching each eye, each lateral one, however, when viewed from the side is seen to be a simple semicircle around the eye; in this it differs distinctly from the following species, in which from the side there appears to be a conspicuous elevation behind the eye, and this elevation is connected by a narrow ridge with a medio-frontal one. In my table it would be associated with *H. niger*, from which it is distinguished by the different excavation and somewhat thinner antennae. On the specimen from Yilgarn the middle of the side of each elytron is pale; on the type the pale portion is scarcely traceable.

HELCOGASTER HOPLOCEPHALUS, n sp.

♂. Black; four basal joints of antennae, except upper-surface of first, obscurely reddish. Very sparsely pubescent.

Head wide, largely and irregularly excavated and tuberculate; with crowded punctures. Antennae comparatively short and stout. *Prothorax* slightly transverse, subbasal depression shallow and ill-defined; with fairly numerous, minute punctures. *Elytra* moderately long; with small and dense, fairly distinct punctures. Basal joint of front *tarsi* with a small comb. Length (♂, ♀), 2·5-3 mm.

♀. Differs in having the head nontuberculate, with two feeble depressions in front, and a very feeble one between eyes, antennae shorter and thinner, and front tarsi simple.

Hab.—New South Wales: Sydney (Dr. E. W. Ferguson). Type, I. 11920.

The excavation on the head of the male is obtusely bilobed posteriorly. Seen from behind the head appears quadrituberculate, the larger tubercles being adjacent to the eye, and distinct from all directions; but from oblique directions it may be seen that the tubercles represent the ends of a narrow curved ridge on each side. The elytral punctures, although small and somewhat rugulose, are much more distinct than is usual in the genus. In my table would be associated with *H. niger*, which is a larger species, with different excavation, and much longer antennae; it is about the size of *H. gagatinus*, and the females are very similar, but the male has very differently sculptured head.

HELCOGASTER COELOCEPHALUS, n. sp.

♂. Black; parts near eyes, and four basal joints of antennae, more or less flavous. Almost glabrous.

Head wide, with a large and irregular excavation, with small tubercles; in parts densely punctate. Antennae rather long. *Prothorax* near apex slightly wider than long, with a shallow, subbasal depression. *Elytra* moderately long; with minute punctures. Basal joint of front *tarsi* lopsided, with an inner black comb. Length, 2 mm.

Hab.—Northern Queensland (Blackburn's collection). Type (unique), I. 11896.

The excavation on the head is trisinuate posteriorly, the median sinus being bounded by an oblique elevation on each side (from some directions the elevations look like small tubercles). The head, viewed from behind, appears to have four small elevations: two black, median, widely triangular ones, and a pale one, curved inwards, at the side of each eye; from the preceding species, in which the ocular tubercles are black, it is also distinguished by the trilobed posterior end of the excavation. In my table it would be associated with *H. niger*, which has thicker antennae, and head very different, when viewed from behind.

HELCOGASTER TRIANGULIFER, n. sp.

♂. Black; labrum and four basal joints of antennae flavous. A few inconspicuous dark hairs on sides.

Head with a deep, irregular impression or excavation in middle. Antennae rather long and obtusely serrated. *Prothorax* slightly longer than the greatest width, base much narrower than apex; a wide subbasal depression, closed at its ends; a few punctures on sides. *Elytra* moderately long; with minute, indistinct, rugulose punctures. Basal joint of front *tarsi* lopsided, with a small black inner comb. Length, 2·25-3 mm.

Hab.—Victoria: Alps (Blackburn's collection), Lorne (F. E. Wilson), Fern Tree Gully (F. P. Spry). Type, I. 11894.

From an oblique direction the head in front of the excavation appears to have an oblique groove near each eye, then an oblique ridge, then another groove, and then a short median ridge; but from other directions the whole space between the subocular grooves appears to be a feeble semicircular elevation, and in fact its appearance varies with the point of view; the excavation has a wide triangle projecting into its middle from the base of the head, so that its posterior end is obliquely directed behind each eye. The basal portion of the head, which, however, is often concealed, is densely punctate. On the type the sides of the head adjacent to the front are obscurely diluted with red.

Two males, from the Dividing Range (Victoria), differ in being more of a piceous-brown than black, with most of the head, base, and sides near base of prothorax, knees and other parts of legs more or less flavous. Three females, mounted with them and evidently belonging to the species, are coloured as the males, except that one has the prothorax entirely pale; they differ in having the head smaller and nonexcavated, with a slight longitudinal elevation in front, and the front tarsi simple. A male, from the Blue Mountains, has the muzzle and sides of head in front of eyes, base of prothorax, and knees, more or less reddish. A male, from Illawarra, is like the preceding specimen, except that the prothorax is entirely pale. All these males agree in having a wide triangle projecting into the middle of the interocular excavation; in my table they would be associated with *H. niger* (except the one from Illawarra); from which they differ in the antennae,. and in the excavation not trisinuate at base. The Illawarra male would be associated with *H. concaviceps*, but its head is of different shape, and differently sculptured, etc.

HELCOGASTER MACROCEPHALUS, n. sp.

♂. Black; labrum, four basal joints of antennae, prothorax, parts of middle and of hind femora, and of tarsi, and most of front legs, more or less reddish. Sides with rather numerous, blackish hairs.

Head rather large, wide, and flat; with two small oblique foveae between eyes, two very small ones in middle behind them, and a shallow longitudinal depression each side in front; with fairly numerous, asperate punctures; towards base densely, transversely strigose. Antennae rather short, third to eighth joints obtusely serrated. *Prothorax* strongly transverse, sides strongly rounded, a wide shallow depression near base; almost impunctate. *Elytra* short, feebly dilated posteriorly; with sparse rugulose punctures. *Legs* not very long, basal joint of front tarsi large, lopsided, and with a black inner comb. Length, 4·5 mm.

Hab.—South Australia: Mount Lofty Ranges (A. H. Elston). Type (unique), I. 12251.

A rather wide species, with head very differently sculptured from the many similarly coloured ones; in width it is second only to *H. major.*

HELCOGASTER OXYTELOIDES, n. sp.

♂. Black, prothorax flavous, basal joints of antennae, tibiae and tarsi, obscurely flavous. With sparse dark hairs, more numerous on sides than elsewhere.

Head rather large; a shallow depression each side in front, with a feeble median elevation between them; apical half shining and with sparse punctures, basal half opaque and with dense ones. Antennae rather long, third to ninth joints distinctly serrated. *Prothorax* moderately transverse, sides and base rounded, a vague open depression near base. *Elytra* short; almost impunctate. Basal joint of front *tarsi* large, lopsided, with a black inner comb. Length, 2·5 mm.

Hab.—Victoria: Sea Lake (J. C. Goudie's No. 829). Type, I. 12123.

The head is much the shape of that of many species of *Oxytelus,* of the Staphylinidae; the impressions on its front are quite distinct, but the head could not be regarded as largely excavated, hence in my table the species would be associated with *H. bilobus*, which has the head even less excavated, and bicolorous elytra. Many of the punctures, at the base of the head, are longitudinally confluent.

A female, mounted with the type by Mr. Goudie, and probably belonging to the species, differs from the male in being smaller (2·25 mm.), in having the pale parts of the legs and antennae more extended, and of a brighter colour, head much smaller, its shining and impunctate portion continued to nearer the base, frontal impressions smaller, antennae shorter, elytra with fairly numerous punctures (which although not sharply defined cause the surface to appear finely rugulose), and front tarsi combless.

HELCOGASTER ATRICEPS, n. sp.

♂. Black; prothorax, basal joints of antennae, and knees more or less flavous. With sparse, dark hairs.

Head rather large, with a deep transverse interocular excavation; densely punctate and opaque. Antennae comparatively long. *Prothorax* about as long as the greatest width (near apex), base much narrower than apex, near base with a wide and rather deep, closed depression. *Elytra* moderately long; with minute, rugulose punctures. Basal joint of front *tarsi* rather large, lopsided, and with a black inner comb. Length, 2 mm.

Hab.—New South Wales: Wentworth Falls (Aug. Simson), Mittagong (A. M. Lea). Type, I. 11908.

In general appearance close to the preceding species, but the head deeply transversely excavated; it is evidently close in appearance also to *H. nigriceps*, but differs from the description in being smaller, head with excavation bisinuate, instead of trisinuate, posteriorly (the sinuations although wide are feeble, and the space dividing them is very obtuse), antennae longer, four of the basal joints partly or entirely pale, and the knees pale. In my table it would be placed with *H. insularis*, which is a much larger species, with the excavation different, the part dividing the sinuations acute, antennae wider, and knees no paler than the adjacent parts. The head of the Mittagong specimen, when viewed from behind, appears to have a minute tubercle on granule close to each antenna, but on the type these are not evident.

HELCOGASTER PIGNERATOR, n. sp.

♂. Black; front of head and a large spot near each eye, prothorax, and part of antennae flavous. With sparse, dark hairs, more numerous on sides of abdomen than elsewhere.

Head rather large, with a wide, sinuous, interocular excavation, its posterior end trisinuate; inter-antennary space irregularly elevated; in parts with dense punctures Antennae moderately long. *Prothorax* slightly longer than greatest width (near apex), a wide but rather shallow and open depression near base. *Elytra* rather long; minutely rugulose-punctate. Basal joint of front *tarsi* lopsided, with a black inner comb. Length, 5 mm.

Hab.—New South Wales: Sydney (A. and F. R. Zietz). Type (unique), I. 11907.

The three conspicuous spots give the head a curious appearance, the front one at first appears to be confined to the inter-antennary space, but is continued along the sides to near the eyes, and passes completely across the under-surface; the other spots are smaller, round, and sharply defined. In some lights the elytra have a faint bluish gloss, and their extreme lateral margins from the base almost to apex are whitish, two of the basal joints of antennae are decidedly flavous, the three following ones gradually become darker, the others are black, the knees and tips of tibiae are obscurely flavous. The pale inter-antennary elevation is somewhat heart-shaped, and gently concave, from behind it appears a feebly trituberculate process, from the side a curved ridge. In my table would be placed with *H. concaviceps*, which is a smaller and broader species, with head differently coloured and excavated.

HELCOGASTER VENTRALIS, n. sp

♂. Black; prothorax, each side of three basal segments of abdomen, and three basal joints of antennae flavous; knees and parts of tibiae and tarsi obscurely diluted with red. With rather sparse, blackish hairs.

Head moderately large, with minute, irregularly distributed punctures, becoming crowded at base; a small shallow depression each side in front. Antennae rather short. *Prothorax* distinctly transverse; subbasal depression shallow and ill-defined. *Elytra* rather short; with minute, rugulose punctures. Basal joint of front *tarsi* moderately large, lopsided, and with a black inner comb. Length, 3 mm.

Hab.—South Australia: Mount Lofty (A. H. Elston). Type (unique), I. 11910.

Structurally fairly close to *H. basicollis*, but frontal fovea of head much less distinct, antennae somewhat shorter, and prothorax uniformly pale. In my table it would be placed with *H. pulchripes*, from which it differs in its darker head, with somewhat different frontal impressions, darker antennae, and abdomen partly pale. The head has a distinctly feminine appearance, but the front tarsi are certainly those of a male.

HELCOGASTER APICICORNIS, n. sp.

♂. Black; prothorax, most of front and of middle legs, hind knees, and part of antennae flavous. With sparse, dark hairs

Head highly polished, with two small but distinct foveae in front, a few minute punctures about base. Antennae rather short, second to fourth joints slightly transverse, fifth to tenth rather strongly transverse, eleventh flat, almost as long as eighth to tenth combined. *Prothorax* distinctly transverse, sides evenly rounded, base and apex equal, a vague depression near base. *Elytra* moderately long; with fairly dense and minute, rugulose punctures. Middle *femora* distinctly dentate, middle tibiae rather strongly curved at base, basal joint of front tarsi large, lopsided, with a black comb from base to apex on inner side. Length (♂, ♀), 2·5-3 mm.

♀. Differs in having the head smaller, antennae shorter and thinner, joints less strongly transverse, apical one smaller and with its tip pointed, middle legs and front tarsi simple.

Hab.—South Australia: Adelaide (Blackburn's collection and A. M. Lea), Mount Lofty (R. J. Burton, A. H. Elston, J. G. O. Tepper, and Lea), Lucindale (B. A. Feuerheerdt, F. Secker, and Lea), Myponga (Elston). , Type, I. 11909.

Readily distinguished from all previously described species by the apical joint of the male antennae; its most distinctive shape is that viewed at right angles to its greatest width, when it appears rather wide and parallel-sided, with its tip slightly notched, from other directions it appears rather narrow and somewhat lopsided; the middle legs are also distinctive, the head is slightly smaller in the female than in the male, but the frontal foveae are much the same. In my table it would be placed with *H. pulchripes*. On the male the tarsi and the base of the middle femora are infuscated, the antennae after the third or fourth joint gradually become darker, but even the terminal joint never appears to be black; on the female a greater portion of the front and middle legs is dark. On fresh specimens the prothorax has a decided reddish tinge.

HELCOGASTER CENTRALIS, n. sp.

♂. Black; head (except at base), prothorax, base of antennae, and most of legs flavous.

Head rather wide, with a rounded fovea occupying one-third of the interocular space; between it and eyes flat, and with crowded punctures; an obtuse elevation in front. Antennae moderately long. *Prothorax* near apex wider than long, but rather strongly narrowed to base, near base with a wide and deep closed depression. *Elytra* rather short, dilated and rounded posteriorly; with very minute, rugulose punctures. Basal joint of front *tarsi* lopsided, with a small black comb. Length, 2 mm.

Hab.—New South Wales (Dr. E. W. Ferguson). Type (unique), I. 11923.

At first glance apparently belonging to *H. foveiceps*, but head with a large central impression, instead of one on each side, the antennae pale only at base, and prothorax of different shape; from *H. hackeri* it is still more distinct. In front of the central fovea there is an elevation which might be regarded as a large tubercle, and hence in my table the species might be placed in *i*, and of those there noted it differs from *H. helmsi*, in being much smaller, head of different shape and colour, and legs variegated; *H. tuberculifrons* has head of different shape, elytra bicolorous and legs flavous. On the type the pale parts of the legs are the apical half of femora, front tibiae and tips of the others, and basal joints of tarsi.

HELCOGASTER LATEROFUSCUS, n. sp.

♂. Head behind eyes, sides of prothorax, scutellum, prosternum, mesosternum, abdomen, seven apical joints of antennae, and parts of legs, black or blackish; elsewhere flavous. With sparse, dark hairs; and very sparse, whitish pubescence.

Head rather long, opaque, and densely punctate; a narrow curved impression on each side from near base of eye to labrum, and a faint median line. Antennae moderately long and obtusely serrated. *Prothorax* about as long as wide, apex slightly wider than base, a shallow, open, subbasal depression; punctures fairly dense on sides, but sparse in middle. *Elytra* moderately long, sides evenly dilated posteriorly; punctures very minute and rugulose. Basal joint of front *tarsi* lopsided, with a distinct black comb. Length (♂, ♀), 3·25-5 mm.

♀. Differs in being larger, head with less prominent eyes, curved impressions shorter and less distinct, median line scarcely traceable, less of the base dark, and front tarsi combless.

Hab.—New South Wales: Rydalmere (Dr. E. W. Ferguson), Gosford (H. J. Carter); Queensland: Rockhampton (Macleay Museum). Type, I. 11922.

The sides of the prothorax are rather deeply infuscated, or blackish, on each of the three specimens under examination, so the dark parts are evidently natural and not stains; hence in my table of the genus the species would be associated with *H. obliquiceps*, which has the elytra entirely dark, head somewhat different, and antennae much shorter. On the male the four hind femora are rather dark on the basal half; the front femora, the middle of the four hind tibiae, and the apical tarsal joints, are slightly infuscated. From in front the head of the male appears to have a shallow semicircular impression, marking off a feebly bilobed interocular elevation. The Rockhampton female, probably a very old one, has the head and tibiae entirely pale.

HELCOGASTER FASCIATUS, n. sp.

♂. Piceous-brown and flavous. With very sparse, white pubescence, and with a few dark hairs; a small fascicle of dark hairs near each eye.

Head wide and irregularly impressed. Antennae comparatively long. *Prothorax* distinctly transverse, base much narrower than apex, a rather deep, closed subbasal depression; punctures rather dense on sides, sparse elsewhere. *Elytra* moderately long, a vague depression on each side of suture near base; with dense, minute, rugulose punctures. Basal joint of *tarsi* with a small black apical comb. Length, 2·5 mm.

Hab.—Queensland: Cairns. Type (unique), I. 11912.

The head is entirely pale, the five basal joints of antennae are still paler, with the following ones more or less deeply infuscated, but the tip obscurely pale; the prothorax is of a dingy reddish-brown, with the front paler, but it has the appearance as of being stained; the elytra (except for a wide, median, flavous fascia), abdomen, mesosternum, and metasternum, are piceous-brown; the legs are almost white, with the femora deeply infuscated. The fascia extends from side to side and is sharply and evenly defined on its posterior end, about two-fifths from the apex; its front edge is somewhat irregular. The cephalic excavations are partly obscured by pubescence; according to the point of view they appear to be three or five in number, but apparently there is a large, shallow, median portion, dilated and bisinuate posteriorly, narrower and bisinuate apically; the two small fascicles are very distinct; the punctures on the head are dense in places, but not sharply defined. Regarding the prothorax as partly dark, the species, in my table, would be referred to D, and there associated with *H. marginicollis*, whose head is very differently sculptured; if referred to DD, it would go with *H. maculiceps* and *H. fuscitarsis*, also with different cephalic sculpture. *Carphurus fascipennis* was described by Fairmaire as having an elytral fascia, but the description differs in many other respects.

HELCOGASTER LATICEPS, n. sp.

♂. Black and flavous. Sides with sparse, dark hairs.

Head wide, a large central fovea closed in front, but open posteriorly, the space between it and each eye flat, densely punctate, rounded posteriorly and joined in front to a small inter-antennary elevation: base with dense, minute punctures. Antennae rather long, obtusely serrated internally. *Prothorax* slightly longer than the apical width, which is distinctly greater than the basal width, a rather wide, deep, closed depression near base, and a small fovea on each side near apex; with small and dense, but unevenly distributed punctures *Elytra* moderately long; with very minute, rugulose punctures. Basal joint of front *tarsi* lopsided, with a small, black, apical comb Length, 2·25-2·5 mm.

Hab.—New South Wales Grenfell (Dr. E. W Ferguson). Type, I. 11924.

The flat space near each eye is densely punctate, but from some directions appears finely granulate; as there is a distinct fovea in the middle of the head the species might be referred to FF of my table, but the head is very different from all the species there noted; the species, however, is allied to *H. foveiceps*, but the head is differently sculptured, and elytra bicolorous. *H. centralis* has the fovea closed posteriorly, and the front of the head with a large, obtuse tubercle, its prothorax is also of different shape, and elytra of one colour. The elytra are coloured somewhat as in *H. imperator*, but the head and prothorax are very different The flavous parts are the head (except at extreme base), prothorax, legs (except coxae and base of femora), and three or four basal joints of antennae; part of the side of each elytron is of a different shade of flavous to the prothorax, the black part commences at the base (near to but not touching the sides), is rapidly narrowed towards the suture, and then continued along it to beyond the middle, when it is suddenly dilated to cover the apical two-fifths. On the type the apical joint of antennae is almost as pale as the basal ones, on a second male the apical joint is scarcely paler than the tenth, and the middle and hind tibiae and tarsi are slightly infuscated.

HELCOGASTER PALLIDUS, n. sp.

♂. Flavous; metasternum and six apical joints of antennae deeply infuscated, middle of elytra slightly infuscated. With rather sparse, pale pubescence, a few darker hairs on sides.

Head not very large, with a large obtuse median elevation; punctures dense and irregularly distributed, becoming confluent about base. Eyes rather larger than usual. Antennae long, thin, and scarcely serrated. *Prothorax* distinctly transverse, apex much wider than base, a wide and rather deep closed subbasal depression; punctures small and sparse. *Elytra* rather long; with fairly dense, minute, rugulose punctures. *Legs* long and thin, basal joint of front tarsi with a small, black, apical comb. Length (♂, ♀), 2·25-3 mm.

♀. Differs in having the head smaller, nontuberculate, two shallow impressions in front, and with sparser punctures, antennae thinner and scarcely infuscated towards apex, prothorax less dilated in front, tip of abdomen infuscated, and legs shorter, with combless tarsi.

Hab.—Queensland: Cairns. Type, I. 11953.

The elytra could hardly be regarded as fasciate, as although the apical fourth and basal third are paler than the intervening portion, this is only vaguely infuscated, especially on the female. There is a shallow depression on each side of the tubercle of the male; on its front edge there is a small fovea, and then a transverse ridge, both fovea and ridge invisible from behind. In my table would be referred to FF, but the head is very different from all the species there noted.

HELCOGASTER THORACICUS, n. sp.

♂. Flavous; apical three-fifths of elytra black, metasternum and six or seven apical joints of antennae deeply infuscated. With sparse, pale pubescence, and with some longer pale hairs.

Head moderately long, with two small frontal foveae; with fairly numerous, small, but distinct punctures. Antennae rather long and thin, second joint distinctly shorter than third. *Prothorax* slightly longer than the greatest width (near apex); a deep, narrow impression across middle, not quite extended to sides, and marking the posterior end of a large depression; a small dark fascicle before and one behind its middle; punctures small but rather sharply defined about base and apex. *Elytra* moderately long; with minute, rugulose punctures. Basal joint of front *tarsi* lopsided, with a black inner comb. Length, 3·5-4 mm.

Hab.—Northern Queensland (Blackburn's collection). Type, I. 9203.

Readily distinguished from all other described species of *Helcogaster* and of *Carphurus* by the prothorax of the male; in my table would be associated with *H. simpliciceps*. On the type the tip of the abdomen (apparently owing to a stain) is slightly infuscated, on a second specimen it is entirely pale.

HELCOGASTER HUMERALIS, n. sp.

♂. Flavous; elytra (except shoulders), metasternum, abdomen, and five apical joints of antennae black. Sparsely clothed with ashen pubescence, and with a few longer hairs.

Head with a wide and deep interocular excavation, its posterior end evenly semicircular; a large flat tubercle in front; punctures dense and small. Antennae rather long, moderately serrated. *Prothorax* about as long as the apical width, which is considerably more than that of base; with a large, transverse, closed, subbasal depression. *Elytra* moderately long; with very minute punctures. Basal joint of front *tarsi* with a small black comb. Length (♂, ♀), 2-2·25 mm.

♀. Differs in being larger, head smaller, of a dingy reddish-brown, with less prominent eyes, a vague curved depression instead of the excavation, and a moderately long obtuse ridge, instead of the frontal tubercle, antennae thinner and less serrated, prothorax narrower in front, scutellum black, elytra with less of the shoulders flavous, abdomen wider, and front tarsi combless.

Hab.—Queensland: Cairns district, a pair taken *in cop.* (A. M. Lea). Type, I. 11925.

In my table would be placed with *H. major*, which is a much larger species, with very different head, elytra entirely dark, etc. At a glance the types look like small specimens of *H. maculiceps*, but the head is without a spot, and differently sculptured.

HELCOGASTER SEMINIGRIPENNIS, n. sp.

♂. Flavous; apical half of elytra, mesosternum, and metasternum black, apical joints of tarsi, and part of antennae infuscated. Sparsely clothed.

Head with a small interocular impression, or short median line, an oblique impression each side in front. *Prothorax* slightly longer than wide, apex slightly wider than base, a fairly large, transverse, closed, subbasal depression. *Elytra* moderately long; with very minute, rugulose punctures. Basal joint of front *tarsi* with a small, black comb. Length, 2 mm.

Hab.—Queensland: Cairns, obtained on sticky seeds of *Pisonia brunoniana* (F. P. Dodd). Type (unique), I. 11914.

The three apical joints of antennae are missing from the type, the three basal ones are flavous, the others infuscated. The visible parts of the head are impunctate, but the base is concealed on the type; between the frontal impressions the surface is gently convex, but it could hardly be regarded as tuberculate. In my table the species would be associated with *H. simpliciceps*, from which it is distinguished by its smoother head, with small but distinct impressions, flavous portion of elytra not produced along sides, and entirely pale abdomen. From *H. thoracicus*, it is distinguished by its smaller size and differently sculptured head and prothorax.

DASYTES CORTICARIOIDES, Lea.

This species occurs in abundance in many parts of South Australia, including Price and Kangaroo Islands. Two specimens, from Swan River, are considerably larger (2·25 mm.) than usual, and rather more robust, but probably represent a variety only.

DASYTES ERYTHRODERES, n. sp.

Black; prothorax, legs (partly or entirely), and basal joints of antennae, more or less reddish or flavous. Clothed with short, ashen pubescence; the elytra, in addition, with subdepressed setae.

Head with rather dense and small punctures. Antennae rather short. *Prothorax* widely transverse, sides and base rounded, hind angles rounded off; punctures minute. *Elytra* at base slightly wider than prothorax, sides feebly dilated in middle; with dense, and rather sharply defined punctures. Length, 2-2·5 mm.

Hab.—New South Wales· Mount Kosciusko, 5,700-6,000 feet (R. Helms); Victoria: Dividing Range (Blackburn's collection), Melton, in February (F. E. Wilson); South Australia: Mount Lofty Range (R. J. Burton). Type, I. 12291.

Readily distinguished from all previously named Australian species by the reddish prothorax; of the nine specimens before me six have it entirely pale, on two the disc is slightly, and on the other deeply infuscated; four specimens (from Mount Kosciusko, slightly larger than the others, and with the prothorax entirely pale) have the femora black; one of the Victorian specimens has the tarsi infuscated, on all the others the legs are entirely pale. From above the clothing appears to be uniform pubescence, but from the sides short setae may be seen on the elytra. On one female specimen the head, from some directions, appears to have two shallow depressions in front.

DASYTES CRIBARIUS, n. sp.

Black, elytra with a slight coppery-green gloss, tibiae, tarsi, and second to sixth joints of antennae somewhat reddish. Clothed with short, ashen pubescence; in addition with numerous suberect, dark setae.

Head with crowded punctures, becoming somewhat larger and sharply defined in front; with two distinct longitudinal impressions in front Antennae scarcely extending to base of prothorax, most of the joints transverse. *Prothorax* scarcely one-fourth wider than long, base slightly incurved at middle, hind angles rounded off; with dense and sharply defined punctures. *Elytra* wider than prothorax, parallel-sided to near apex, with dense punctures, at base slightly larger than on prothorax, becoming smaller posteriorly; with faint remnants of striation. Length, 2·75 mm.

Hab.—South Australia: Mount Lofty Ranges (J G O. Tepper). Type (unique), I. 12283.

Distinguished from all previously named Australian species, except *D. fuscipennis*, by the upright clothing on prothorax, in addition to the pubescence; from that species it is distinguished by its narrower and more convex form, much smaller eyes, prothorax with much denser and smaller punctures, elytra with a metallic gloss, and with smaller punctures, etc.

DASYTES HEXATRICHUS, n. sp.

Black; upper-surface with a coppery gloss. Densely clothed with short, depressed, pale pubescence; head in addition with two long hairs, and two on each side of prothorax.

Head rather wide, with small crowded punctures, with two conspicuous longitudinal impressions in front, the intervening space bronzy. Antennae rather short, some of the joints transverse. *Prothorax* almost twice as wide as long, sides and base finely margined, hind angles rounded off; with crowded and small, asperate punctures. *Elytra* distinctly wider than prothorax, parallel-sided to near apex; with crowded and small punctures, mostly separately impressed, but in places asperate and subconfluent. Length, 3·25-4 mm.

Hab.—Western Australia: Cue (H. W. Brown). Type, I. 12287.

Structurally close to *D. squiresensis*, but elytra pubescent only, and six long hairs on head and prothorax; *D. abundans*, with similar hairs, is a much smaller species, with legs and antennae partly pale, and frontal impressions much less conspicuous.

DASYTES ABDOMINALIS, n. sp.

Black. Densely clothed with ashen pubescence, the elytra in addition with numerous subdepressed setae.

Head with dense and small punctures, rather more distinct about base than elsewhere; two vague depressions in front. Antennae short, most of the joints transverse. *Prothorax* almost twice as wide as long, sides and base rounded and very finely margined, hind angles rounded off, a vague transverse depression near base; punctures minute. *Elytra* very little wider than prothorax at base, sides feebly dilated to near apex; with dense and rather sharply defined punctures, in places slightly confluent, and becoming smaller posteriorly. Length, 2·5-3 mm.

Hab.—Western Australia: Yilgarn (Blackburn's collection, from E. Meyrick). Type, I. 12288.

Rather more robust than *D. australiae*, impression near base of prothorax fainter, and elytral clothing of two kinds;

seen from above it appears to be uniform, but from the sides there may be seen numerous short sloping setae, amongst the pubescence, in consequence, in my table,(21) the species would be associated with *D. squiresensis*, from which it differs in having the setae less erect, and in its entirely dark legs. On one sex the apical segment of the abdomen is widely concave in the middle, and with a subtuberculate swelling on each side. On a few specimens the upper-surface, or the elytra only, have a very feeble metallic gloss

DASYTES PICTIPES, n. sp.

Black; parts of antennae and of legs flavous. Clothed with short, depressed, ashen pubescence.

Head with rather dense and minute punctures; two vague depressions in front. Antennae rather short. *Prothorax* widely transverse, sides and base rounded and finely margined, hind angles rounded off, a shallow transverse depression near base; with dense and small punctures, larger near base than elsewhere. *Elytra* very little wider than prothorax at base, sides slightly dilated to near apex; with dense and small, but sharply defined punctures. Length, 2-2·25 mm.

Hab.—New South Wales: Dorrigo (W. Heron). Type, I. 12286.

Of the eight specimens before me the tibiae and tarsi are pale on all, most of them have the trochanters and knees pale, and one has the entire front legs pale; the antennae are entirely pale, or with some of the apical joints infuscated; parts of the muzzle are also pale. In my table would be associated with *D. bourgeoisi* (n. pr., now *D. julesi)*, from which it differs in being smaller, and prothorax with a shallow subbasal depression; *D. australiae*, with somewhat similar depression, is slightly less robust, and with entirely dark legs and antennae.

DASYTES ELLIPTICUS, n. sp.

Black; antennae (apical half infuscated) and legs (middle and hind femora more or less deeply infuscated) flavous. Clothed with short, ashen pubescence.

Head with small and fairly numerous punctures, two feeble depressions in front, and a still more feeble one in middle. Antennae slightly passing base of prothorax, fifth joint distinctly smaller than fourth or sixth. *Prothorax* at base almost twice as wide as long, front convex in middle, strongly rounded to sides, base and sides finely margined;

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(21) Lea, Trans. Ent. Soc. Lond., 1909, p. 240.

punctures minute and inconspicuous. *Elytra* at base scarcely wider than base of prothorax, sides feebly dilated to about middle, with dense and small, but rather sharply defined punctures. Length, 2·5-2·75 mm

Hab.—South Australia: Parachilna (E L. Savage). Type, I. 12284.

The sides of the elytra have short, semidecumbent setae posteriorly; they are fairly numerous, but distinct only from the sides, there is also a short hair projecting outwards from each side of the base of the prothorax. Very faint remnants of a subbasal depression may be seen on each side of the prothorax. It is an elliptical species, and in my table would be associated with *D. bourgeoisi* (now *D. julesi)*, from which it differs in having more of the legs pale, prothorax larger, with the base wider, elytra somewhat shorter and wider and with smaller punctures; structurally it is rather close to *D. blackburni (D. helmsi*, n. pr.), but the prothoracic punctures are much smaller, and the legs are partly pale.

THE REDISCOVERY OF CHORIPLAX (MICROPLAX) GRAYI, ADAMS AND ANGAS (ORDER POLYPLACOPHORA, WITH NOTES ON ITS TRUE PLACE IN THE NATURAL SYSTEM AND THE DESCRIPTION OF A NEW SUB-SPECIES.

By EDWIN ASHBY, F.L S., M.B.O.U.

[Read July 14, 1921.]

PLATE IX.

Microplax grayi, H. Ad. and Ang., P.Z.S., 1864, p. 194; *l.c.*, 1865, p. 58, t. 11, f. 16. Angas, P.Z.S., 1867, p. 224. Carpenter, MS., p. 12. Pilsbry, Man. of Con., vol. xiv., p 21.

Choriplax grayi, H. Ad. and Ang. Pilsbry, Nautilus, vii., p. 139, 1894. Thiele, Rev. des Sys. der Chitonen. Zool., iv., 1910.

It is with pleasure that I acknowledge my indebtedness to Dr. W. G. Torr for the opportunity of examining and describing one of the most interesting chitons it has been my privilege to examine. On May 7 last I received from him a few chitons for identification, all taken by Mr. George Pattison, near Cape Banks Lighthouse. One, he said, was not only a species new to him, but also belonged to a genus he had never seen before. I saw at once that the specimen was a remarkable find, evidently related to the genus *Amicula*, a genus whose habitat is in the cold waters of the North Pacific, from the Okhotosk Sea to the Behring Sea, and in corresponding latitudes on the eastern side of the North American continent.

Genus *Microplax*, Adams and Angas, 1864. Original description:—"Insertion plates smooth and thin, present in all the valves. Sutural plates obsolete, the sinus extremely shallow. Girdle thin, horny, most minutely granulous. Valves largely concealed in the girdle, the exposed portions small and separated.

"In the present genus a small portion only of each valve is exposed, and the sutural plates and sinus are obsolete. No other chiton having unslit insertion plates approaches this remarkable group."

M. grayi, Adams and Angas. Original description:—"Shell elongated, convex, brown; exposed portion of the valves minute, wide heart-shaped, carinated, strongly granulated, the intervals between the exposed parts of the valves about as long as the latter. Lateral areas defined by a distinct rib. Girdle moderate, corneous, smooth. Length, 13; width, 5 mill. Sydney Harbour, Australia; under stones at low water."

CHORIPLAX GRAYI PATTISONI, n. sub-sp.

Differs from *C. grayi*, Ad. and Ang., in its greater width and in the fact that the tegmentum is proportionately smaller. The measurements of *C. grayi*, s.s., are quoted by Pilsbry (*l.c.*, pp 21, 22), are: length, 13; width, 5 mm. Tegmentum, 1½ × 1¾ mm. Whereas the measurements of the present specimen are 18 × 8½ mm., and the tegmentum 1½ × 1 mm.

An examination of the drawings made by E A. Smith and figured by Pilsbry (*l.c.*, pl., figs 9-11) will further explain these differences.

General Appearance.—Broadly oval, the posterior valve being much larger than the anterior. The tegmentum reduced to a small, heart-shaped, raised portion at the apex of each valve, this portion being pink. The balance of the shell is olive-green, due to an extension of the epidermal layer of the girdle over the whole of each valve, with the exception of the small, raised, heart-shaped tegmentum before referred to. The epidermal skin is minutely granulose, semi-transparent, and free from scales, hairs, or spicules.

Colour.—The small, heart-shaped, exposed portions (or tegmentum) are Prussian Red with flecking of Ochre Red (Ridgway's Colour Standards, pl. xxvii.). The epidermal covering of the highly developed articulamentum portions of the shell is, in a good light, olive-lake, merging into Saccardo's olive, in the shaded or overlapping portions of the sutural laminae (*l.c.*, pl. xxix.). The girdle is warm sepia, or a little darker.

Inside of Shell.—Transparent, pearly, and very highly polished. The plates are so thin and delicate that none of them are quite unbroken on the interior margins. The anterior margin of the sutural laminae is almost straight, the suture is reduced to a mere inward bend imperceptible in several of the valves.

Anterior Valve. — The small exposed portion is semicircular; the apex, which in this species corresponds with the mucro of the tail valve, is pronounced and approximately smooth, the superficial layer semitransparent, showing subcutaneous dark and light streaks radiating from the mucro. These may easily be mistaken for grooves and ridges. This smooth area is produced anteriorly for fully one-third of the width of the tegmentum. The balance of the valve is sculptured with rather widely spaced granules. There seems no consistent arrangement of these. The mucro is anterior to the posterior margin of the tegmentum, and the posterior lobes of the articulamentum unite behind same.

Median Valves.—The small exposed tegmentum is heart-shaped, posterior margin curved, in some straight, furnished with a broad beak or mucro, the tegmentum being continued behind this. The dorsal area is distinct and broad with almost parallel sides. The portion immediately in front of the mucro is usually coarsely longitudinally ribbed, more or less broken. In some of the valves these ribs continue to the anterior margin, in others they are replaced by subcutaneous lining. In this anterior portion, irregular raised pustules also occur to a limited extent in some of the valves. Although these irregularities exist, the chief character of this part of the shell is strong, longitudinal ribbing. A strongly-raised, diagonal rib commences at the mucro and dies away about half-way across the tegmentum dividing the lateral from the pleural area. The pleural area is sculptured with irregularly-shaped, rough-looking pustules. There is a tendency for these to become confluent along lines parallel with the ribbing in the dorsal area In the lateral areas the raised portions or granules are even more irregular in shape than is the case in the pleural area. Behind the mucro and diagonal rib the subcutaneous line-marking is radial, and very marked in some valves. As before stated, the mucro is anterior to the posterior margin, and the posterior lobes of the insertion plates unite behind the tegmentum.

Posterior Valve.—The anterior portion of the tegmentum is less pointed than is the case in the median valves, the posterior part semicircular. Mucro anterior, a number of dark subcutaneous streaks radiate from the mucro posteriorly in a fan, with a highly-polished, semitransparent surface, but it is not truly smooth; this character occupies about one-quarter of the length of the tegmentum and is fan-shaped. That part of the valve behind the mucro is sculptured fairly evenly with circular pustules placed more or less concentrically. The anterior portion is longitudinally ribbed, but, in addition, there are coarse irregular pustules. This valve is large, measuring 4 × 7 mm., the tegmentum placed centrally.

Girdle.—In the dry specimen is wrinkled, bearing neither scales, hairs, or spicules; has a gelatinous or horny look, is dark in colour, and, with shrinking, has curved inside the shell to a width of ·75 mm. The girdle is thickened over the marginal portion of the insertion plates, forming a dark band round the shell 1 mm. in width or with the incurved portion referred to a total girdle width, in dry specimens, of 1·75 mm.

Measurements.—Length, 18 × 8½ mm. The tegmentum, or exposed part, reaches a maximum width of 1½ mm. by 1 mm. longitudinally, in one of the median valves, whereas the articulamentum in valve 6 is 3 mm., longitudinally, by 8 mm. in width.

Habitat.—The specimen under review was found near Cape Banks Lighthouse, in South Australia. The following are Mr. Pattison's own words:—"A heavy sea tore off the big kelp *(Laminaria)* outside the reef and washed it up on the beach. The chiton was amongst the kelp, on the beach, and the sea lice had probably eaten the fish out" These facts and the flat, fragile character of the shell, with its green-brown, transparent, epidermal covering, suggest the probability of its living on the stems of the kelp under which it was found. While the discovery of the host plant of the genus *Stenochiton*, as described in my monograph (Trans. Roy. Soc. S. Austr., vol. xlii., 1918), has led to their discovery in some of the other States, is it not quite feasible that a similar search on the stems of some forms of algae may reveal a race of Polyplacophora living thereon

Remarks—This remarkable shell presents many unique features, the extremely reduced area of the tegmentum, the modified character of the sutural laminae, the exceptional development of the insertion plates, the partial or entire absence of slits, the transparent granula epidermal covering, and the peculiar posterior lobing of the insertion plates, widely separates this from any other known form in Australian waters, and, I believe, no near ally has up to the present been discovered in the Southern Hemisphere. Perhaps the nearest relative in our southern seas is the New Zealand shell, *Cryptoconchus porosus*, Burrow; but that species cannot be said to be very closely allied, as it only possesses a few characters in common. I have quoted the original description of both genus and species as published by Dr. Pilsbry in his famous Monograph. In the main my description, which has been written without any special reference to the earlier writers, will be found very closely to correspond therewith, but there are some rather important differences. In the first place, the sutural laminae are by no means obsolete, as stated by Adams and Angas, and there is considerably more overlapping of the valves than was noticed by Carpenter, the laminae, in some valves, reaching fully two-thirds across the tegmentum. The insertion plates are abnormally developed; in fact, this species seems to have specialized in this form of development, and, in some measure, adapted the character of the tail valve to the median valves. The lateral insertion plates are joined behind the tegmentum and produced, posteriorly, in two lobes with a sinus between them, a feature that is present in a very modified form in the tail valve of some of the Acanthochitons. While in the undissected shell under examination I cannot detect any slits in any of the insertion plates, I cannot say that they do not exist in a modified form. The interior of the tail valve is radially grooved and scored, until the girdle is approached, when the grooves appear to terminate. I would suggest the probability that in the juvenile stage some evidence of slits may exist and disappear in the mature or senile form.

Classification.—While it is to be greatly regretted that the animal and radula are missing, and also that permission has not been obtained to disarticulate some of the valves, the transparency of the shell has made this latter less important than is usually the case, I have been able to note sufficient features to justify one in removing the genus *Choriplax* (=*Microplax*) out of its setting in our previous classification. I can see no justification for placing a species with abnormally developed insertion plates under the Lepidopleuridae. Had the animal been present and the valves disarticulated, there would have been but little difficulty in finding its true place in the Natural System or Taxis. In spite of these limitations, the characters that it has been possible to observe are sufficient to warrant our placing the genus *Choriplax*, Pils., near the genus *Amicula*, Gray. For reasons given hereunder I should place it between *Amicula* and the Subfamily *Cryptochitoninae.* The characters of the genus *Amicula*, Gray, are given by Pilsbry (in Man. Con., vol. xv., p. 43) as "Valves almost covered by the extension of the girdle over them, leaving only a small, rounded, or heart-shaped portion exposed at the apex of each; posterior borders of valves produced backwards in rounded lobes at each side, the lobes completely separated by a posterior sinus having the tegmentum at its apex. Posterior valve having a posterior sinus and one slit on each side. Girdle more or less pilose, often having pore rows. The essential features of *Amicula* are its small exposed portion or tegmentum, situated at the posterior edge, and not extending forward to the sinus, its mopaloid posterior valve, short contour, and short gills."

The species under consideration corresponds with *Amicula* in some of its most striking features, but, although like the *Amicula*, the tegmentum does not extend forward to the sinus; unlike that genus it does not extend to the posterior margin, neither have we noticed any slit, nor is the girdle pilose.

The description of the *Cryptochitoninae*, in the same work, p. 48, is: "Valves entirely concealed in the leathery girdle and lacking tegmentum; their posterior margin produced backwards in a deep lobe on each side, the lobes united across the median line, causing the apices of all valves to be removed inwards from the posterior edge, slits sub-obsolete or lacking in the intermediate valves, girdle covered with minute tufts or bristles." It will be noticed that two of the distinguishing features of the *Cryptochitoninae* are present in

Choriplax but absent in *Amicula*, namely, the sub-obsolete or lacking slits, in the median valves and the posterior lobes of the articulamentum uniting across the median line, causing the apices of all valves to be removed inwards from the posterior edge.

While Dr. J. Thiele (Rev. des Sys. der Chitonen, pt. ii, pp. 106 and 116) leaves the genus *Choriplax* under the Lepidopleuridae between *Hanleya*, Gray, and *Oldroydia*, Dall, did so evidently with considerable misgivings. I cannot follow him in placing the two genera *Katharina*, Gray, and *Amicula*, Gray, under the Mopaliidae, and think Pilsbry is right in placing them immediately before the genus *Cryptochiton*. I would also suggest the recognition of the genus *Cryptoconchus*, Blain. and Guilding, with *C. porosus*, Burrow, as type, and placing it between *Loboplax*, Pils., and *Katharina*, Gray. With its striking development of the articulamentum posteriorly, in two lobes, its reduced tegmentum, and pores often sub-obsolete, it seems a sort of "half-way house" between those genera.

Finally—I propose that the genus *Choriplax*, Pils., be taken out of its previous setting amongst the less specialized group, the Lepidopleuridae, and be placed under the Family Acanthochitidae, Pils., following the genus *Amicula*, Gray, and preceding the genus *Cryptochiton*, Midd and Gray The apparent absence of slits in the insertion plates is, I suggest, probably due to modifications in a very specialized form, brought about by the peculiar habits of the chiton. The same tendency is already apparent in the genus *Cryptochiton* where the slits in the median valves have either been lost entirely or become sub-obsolete.

Revised definition of the Genus Choriplax, Pils.—Valves are almost covered by the extension of the girdle over them, the tegmentum or exposed part being reduced to a small, heart-shaped portion, exposed at the apex of each; the insertion plates highly developed, smooth and thin, extending posteriorly in a deep lobe on each side, the lobes united across the median line, causing the apices of all valves to be removed inward from the posterior edge. The sutural laminae are apparently shallow, united across the median line, and the sinus reduced thereby to a mere inward bend. Girdle thin, horny, minutely granulose.

If we are justified in placing the genus *Cryptochiton* under the Subfamily Cryptochitoninae, may we not be justified in doing likewise for this remarkable genus, retaining Adams and Angas' name under the name of a subfamily called Microplaxinae with *Choriplax grayi*, Ad. and Ang., as the type, taking the foregoing description as the definition of the subfamily, with the addition of any new features the later examination of the soft parts may reveal? So naturally does this genus seem to fit into the place I have assigned to it, that the wiser course might possibly be to place both *Choriplax* and *Cryptochiton* under the Family Acanthochitidae, Pils., and drop the Subfamily Cryptochitoninae.

Note.—In the writer's last paper on Australian Polyplacophora (Trans. Roy. Soc. S. Austr., vol. xliv., p. 286, 1920) reference is made to the race of *Callistochiton meridionalis*, Ashby, which had been previously described from a single specimen from North-west Tasmania, and to which he had attached the name of *mayi*. Since this was written several specimens from the same district have come to hand, and while some show the same backward habit of developing the typical network sculpture that was noted in the paper referred to, other specimens are almost normal. Had more material been available at the time the then unique specimen was described, the writer would have contented himself with simply noting the fact that shells from this North-west Tasmanian coast attain the adult characters more slowly than is the case with those from the type locality in South Australia. In the same paper, p. 283, *Lepidopleurus inquinatus*, should be of Reeve, and not Blainville, as printed, and *L. catenatus*, Hed. and Hull, should have been withdrawn from the Australian fauna, it being a Lord Howe Island species.

Addendum.—Since presenting the foregoing paper I have had the opportunity of reading in the Nautilus, vii., p. 139, Dr. Pilsbry's note attached to his proposed substitution of the name *Choriplax* for that of *Microplax*, which name was preoccupied, and I now quote his remarks in full:—"This is an extremely peculiar and isolated genus, and forming, I am disposed to believe, a distinct family of the Eoplacophora, or slitless chitons; that is, if the slits really prove to be completely absent, for the unique type has not been disarticulated. In some features it recalls the Acanthochitidae. The single specimen was described and illustrated from the unique type in the British Museum, in the Manual of Conchology, vol. xiv."

DESCRIPTION OF PLATE IX.

Fig. 1*a*. *Choriplax grayi pattisoni*, Ashby, upper side, × about 5. Showing small heart-shape tegmentum and enveloping epidermis with tear in valve 2 revealing smooth articulamentum underneath.

Fig. 1*b*. *Choriplax grayi pattisoni*, Ashby, interior of shell, ×5. Showing sutural laminae.

Fig. 1*c*. *Choriplax grayi pattisoni*, Ashby, upper side with strong light thrown through the shell showing *(a)* shadow of sutural laminae, *(b)* opacity of tegmentum, *(c)* the posterior lobes united across the median line, ×5.

AUSTRALIAN COLEOPTERA.—PART II.

By ALBERT H. ELSTON, F.E.S

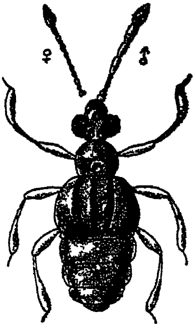
[Read August 11, 1921.]

PSELAPHIDAE

CTENISOPHUS CURVIPES, n. sp.

♂. Pale castaneous, with parts of elytra paler Moderately clothed with short, white pubescence, becoming setae at apex of elytra, and absent from the middle of prothorax and elytra.

Head with a few more or less concealed subrugose punctures and two large shallow foveae between the eyes. Antennae long and moderately stout, the first two joints about twice as wide as joints three to seven, the first about as long as second and third combined, the second little more than half the length of the first, third to seventh are equal in length, each being slightly longer than half the length of the second, the eighth cylindrical, and about as long as joints three to seven combined, and as wide as the second, the ninth about two-thirds the length of the eighth and wider at apex than at base, the tenth perceptibly longer than the ninth, and the apical joint about as long as the tenth, wide near the base and obtusely pointed. *Prothorax* about as wide as long, narrower at apex than at base, with a few scattered punctures, and a moderately large subbasal fovea. *Elytra* at base distinctly wider than prothorax, the margins sloping outwards towards apex, a longitudinal furrow on each elytron, starting from about midway between the suture and humeral angle, thence to the apex, and with a short subsutural stria; with minute scattered punctures. *Metasternum* with a deep furrow starting from near the coxae of the intermediate legs and touching the coxae of the posterior ones. *Abdomen*, dorsal surface with a few small punctures arranged in transverse rows, ventral surface impunctate, the third segment large with very small and shallow round foveae. *Legs* long and moderately thin, the anterior tibiae strongly curved, the intermediate slightly curved, and the posterior ones almost straight, all are dilated towards the apex. Length (♂, ♀), 1·5 mm.



Ctenisophus curvipes, n. sp.

♀. Differs in the antennae being shorter and thinner, the eighth to tenth joints being much shorter, the apical about as long as the ninth and tenth combined, and much wider, the eyes smaller; and the abdomen somewhat larger with its ventral surface nonfoveate.

Hab.—South Australia: Murray River near Morgan, flew to lamp at night (A. H. Elston). Type, in author's collection; co-type, I. 10934, in South Australian Museum.

The four long apical joints of the male antennae associate this species with *C. longicornis*, Lea, and *C. rivularis*, Lea, but it is readily distinguished from these and all other previously described species by the strongly curved front tibiae, these being quite as strongly curved in the female as in the male.

SCAPHIDIIDAE.

SCAPHISOMA BRYOPHAGA, n. sp.

Ovate, shining red, towards apex of elytra and tip of abdomen diluted with flavous, antennae and tarsi testaceous, club infuscated; scantily clothed with minute bristly hairs

Head with a few minute, scattered punctures, antennae long and slender, with three-jointed club, the first two bead-like in shape, the apical longer than the penultimate and subovate. *Prothorax* transverse, sides evenly rounded, basal angles acute, with a very faint transverse subbasal impression and a few minute, scattered punctures. *Scutellum* semicircular in shape. *Elytra* elongate, each with a distinct, slightly curved subsutural stria, starting from near the sutural angle, becoming fainter posteriorly and vanishing before apex; slightly punctured, the punctures minute and somewhat seriate. Length, 1-1·5 mm.

Hab.—South Australia: Myponga, taken in moss (R. F. Kemp, A. H. Elston). Type, in author's collection; cotype, I. 12829, in South Australian Museum.

This species may be chiefly distinguished by its size and colour; the punctures, out of which the hairs emanate, are very feeble and barely perceptible with a simple lens.

CLERIDAE.

PHLOGISTUS.

The generic name *Aulicus* must now be eliminated from Australian catalogues; Gorham (1) considered that the American species should be separated from the Australian, and suggested the new generic name *Phlogistus* for the latter, Spinola having considered the type of *Aulicus* to be *nero*, not *instabilis*, as taken by Lacordaire. Blackburn ⁽²⁾ commented on the above, but owing to the absence of a diagnosis of *Phlogistus*, retained the name of *Aulicus*. A description of the new genus has been supplied by Schenkling.⁽³⁾

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(1) Gorham, Cist. Ent., vol. ii., p. 84.

PHLOGISTUS IMPERIALIS, Gorham.

This insect was originally described from Queensland. I have now to record it from New South Wales, Victoria, South Australia, and Western Australia. As suggested by Hintz,⁽⁴⁾ there is no doubt Blackburn failed to recognize this species, but confused it with *P. episcopalis*, Spin., which name I have seen in his handwriting attached to colour varieties of *imperialis*. The latter species is very variable in colour, and apparently Blackburn had not seen a specimen of the typical colouring, otherwise he would probably have recognized it from the description given by Gorham. This species may be readily distinguished from *episcopalis*, Spin., *inter alia*, by its deep, quadratic, and reticulate punctures; those on the latter species being more shallow, not so square, and *not* reticulate.

PHLOGISTUS CORALLIPES, Chev.

A specimen from Tasmania differs from the typical form in having dark mouth parts and legs, only the front tarsi being reddish.

PHLOGISTUS MUNDUS, Blackb.

I have taken this species in the Flinders Ranges, South Australia, together with a colour variety, which has the head and prothorax almost black, the base and apex of elytra a beautiful bright violet, the middle part bearing punctures of a coppery tint, the legs blue, with the exception of the front tarsi and the under-surface of the front tibiae, which are ochraceous.

PHLOGISTUS MODESTUS, Blackb.

Blackburn in his description of the above mentions a variety, "pedibus sordide testaceis," as being probably only an immature specimen. I have in front of me nine specimens taken in the Mount Lofty Ranges, South Australia; they all have their legs testaceous, and do not appear in any way to be immature.

PHLOGISTOMORPHA.

This genus was proposed by Hintz⁽⁵⁾ to receive four species of *Phlogistus*, *viz.*, *blackburni*, Schenk.; *apicalis*,

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(2) Blackburn, Trans. Roy Soc. S. Austr., 1900, p. 122.

(3) Schenkling, Gen. Insect., Fasc. 13, 1903, p. 56.

(4) Hintz, Deut. Ent. Zeit., 1908, p. 709.

(5) Hintz, *loc. cit.*, 1908, p. 715.

Macl.; *croesus*, Blackb.; and *mastersi*, Macl., and is easily distinguished from the preceding genus by the terminal joint of the antennae, which has an almost quadratic form, and drawn out into four points with a bay in between each two of them.

PHLOGISTOMORPHA CROESUS, Blackb.

Specimens of this beautiful insect have been taken by Mr. J. C. Clark in Western Australia. It was originally described from South Australia.

PHLOGISTOMORPHA BLACKBURNI, Schenk.

The habitat of this insect was given by its author as "Australia." I have now to record it from Victoria and South Australia.

TROGODENDRON MONSTROSUM, Gorham.

There are two specimens, a male and female, of this remarkable insect in the South Australian Museum, taken at Bowen, Queensland. The male, which has the bifid termination of the apical joint of the antennae, differs from the author's description in having the prothorax strongly, the head slightly diluted with red, the palpi and labrum reddish-yellow; the lunate-shaped fasciae behind the middle of elytra have, particularly on the posterior part, narrow reddish-brown margins, which extend nearly to the suture, the oblique guttae near the apex have likewise reddish-brown fringes which are wider than the raised ivory portion. The female differs from the male in being much smaller, not having the apical joint of antennae bifid, and the reddish-brown margins on the fasciae and guttae less conspicuous or entirely absent.

TROGODENDRON RUFIPES, n. sp.

Upper-surface black, diluted here and there with blue, palpi, antennae, and legs red; slightly raised median fasciae on elytra ivory, with wider fasciae in front of, and touching, red; somewhat scantily clothed with long dark, interspersed with pale, hairs, apical fourth of elytra densely clothed with fine, depressed, golden hairs. Under-surface black, very scantily clothed with pale hairs.

Head densely punctured, the punctures small and somewhat rugose. Antennae extending nearly to base of prothorax, second joint about as long as wide and slightly wider at apex than at base, three to eight longer than wide, nine and ten much wider and obconical in shape, the apical about half as big again as the tenth, the outside apical angle rounded and the inside one obtusely pointed. *Prothorax* about as long as wide, base much narrower than apex, somewhat globular, with a transverse impression near the apex, sides rounded and very much constricted at base, closely punctured, the punctures moderately large, deep, and in places slightly confluent. *Elytra* wider than prothorax and about thrice as long, sides slightly constricted near middle, to beyond the middle with large, deep, seriate punctures. On each elytron near the suture are two large protuberances, which have the sides almost as largely and deeply punctured as the rest of elytra, and the apices only slightly punctured. *Legs* long and slender. Length, 15 mm.

Hab.—Queensland: Bribie Island (H. Hacker). Type (unique), in Queensland Museum.

Very distinct, and not readily associated with any previously described species. The median fasciae are slightly oblique, touching the margins but not reaching the suture, the reddish patch is extended beyond the ivory one and almost touches the suture. The basal joint of the antennae is infuscated on the outside, and the second half of the apical is slightly paler than the rest of the antennae.

TROGODENDRON TENEBRICOSUM, n. sp.

Black; palpi, antennae, legs (femora excepted), and postmedian fasciae testaceous, upper-surface scantily clothed with moderately long, nearly upright, black hairs, except on legs which have pale hairs, and near apex of elytra with small patch of silvery hairs; under-surface very scantily clothed with grey hairs.

Head with a long transverse impression near base of antennae, closely punctured, the punctures moderately deep and rugose. Antennae stout, joints three to five a little longer than wide, six to ten obconical and gradually increasing in width, the last obtusely pointed at apex. *Prothorax* slightly longer than wide, sides rounded near middle, with a moderately deep transverse impression near apex and a deeper subbasal one; with dense punctures, larger than those on head, more or less rugose, and defining a longitudinal median carina. *Elytra* at base one and a half times as wide as middle of prothorax and more than thrice as long, humeral angles salient; to beyond the middle with large, deep, quadratic and seriate punctures, those on the fasciae a little smaller and nearly round, impunctate on humeral angles and behind fasciae. Length, 10-15 mm.

Hab.—Victoria: Melbourne (E. Fischer). Type, in author's collection.

I have before me only two specimens, sent me by Mr. F. E. Wilson, of this species, which is apparently very variable in size. The post-median fasciae touch the margins and extend somewhat obliquely upwards towards the suture, but not quite touching it. The impunctate parts of elytra are glistening; the protuberances near the scutellum are rudimentary, only a small shagreened patch being visible, the knees are sometimes diluted with red and parts of the tibiae are infuscated. Comes nearest to *T. ephippium*, Boisd., from which it can be easily distinguished, *inter alia*, by the punctures on the head and prothorax being larger, disc of prothorax without deep depression, and the absence, near base of elytra, of two protuberances bearing tufts of hair.

ZENITHICOLA FUNESTA, Chev.

Hab.—Stradbroke Island, Queensland, New South Wales, Victoria, South Australia, Western Australia.

ZENITHICOLA CRASSA, Newm.

Hab.—Queensland and New South Wales.

EUNATALIS.

Schenkling (6) stated that the genus *Natalis* of Castelnau (1836) was founded upon *N. laplacei* from Chili; to this genus were afterwards added two other Chilian and many Australian species. Subsequently (1906) for *N. punctipennis*, Germ. (from Chile), Schenkling proposed the genus *Neogyponyx*, but this must now be regarded as a synonym of *Natalis*. Klug (1842) did not recognize *Natalis* as a valid genus, but Spinola (1844) did so, incorrectly giving *porcata*, Fab., as its type; he was followed by most authors until recently. Schenkling (1909) therefore proposed that the three Chilian species should remain in *Natalis*, and the name *Eunatalis* be substituted for the Australian species.

STIGMATIUM VENTRALE, Macl.

This species is variable in size, ranging from 7 mm. to 10 mm. in length. It has now to be recorded from Queensland, Stradbroke Island, and South Australia.

STIGMATIUM GILBERTI, White.

This insect is widely distributed in Australia, and somewhat variable *inter se*. On two South Australian specimens there is a distinct dark narrow band across the reddish portion of the elytra, about midway between the base and where the black commences; the oblong subapical spots of pale hairs extend right to the apex.

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(6) Schenkling, *loc. cit.*, 1909.

PHAEOCYCLOTOMUS CHLOROPUS, Kuw.(7)

This insect was originally described from New Guinea. I have now to record it from North Queensland.

ELEALE.

The insects belonging to the genus *Eleale* are, with two exceptions, peculiar to Australia. I have not yet seen either *E. advena*, Chev., from Chile, or *E. pantomelas*, Boisd., from New Zealand, so am unable to speak with any degree of certainty, but believe that these two species have been incorrectly assigned to it. The members of this genus, as indeed with some of the allied genera, are very variable both in colour and size, and in compiling the following table I have endeavoured, as much as possible, to distinguish the species by their sculpture, and have only resorted to colour when there could be no danger of confusion or variability of the species. Only those species that I have been able to identify with confidence have been included in the table:—

A. Elytra bicoloured, in parts testaceous.	
a. Apex of elytra pale	*lepida*, Pasc.
aa. Apex of elytra dark.	
b. Apical joint of antennae distinctly emarginate	*pulchra*, Newm.
bb. Apical joint of antennae not distinctly emarginate.	
c. Base of elytra pale or not entirely dark.	
d. Prothorax tranversely wrinkled	*apicalis*, Macl.
dd. Prothorax not transversely wrinkled	*pallidipennis*, n. sp.
cc. Base of elytra entirely dark.	
e. Prothorax tranversely wrinkled	*sellata*, Pasc.
ee. Prothorax not transversely wrinkled	*fasciata*, Macl.
AA. Elytra unicoloured, not testaceous in parts.	
B. Punctures on disc of prothorax transversely wrinkled.	
f. Apical joint of antennae emarginate.	
g. Sides of prothorax straight.	
h. Antennae pale, club dark ...	*smaragdina*, Chev.
hh. Antennae metallic, club black	*aspera*, Newm.
hhh. Antennae metallic, club reddish-brown	*viridicollis*, Macl.
gg. Sides of prothorax rounded.	
i. Apex of elytra lightly punctured and glistening.	
j. Club of antennae black.	
k. Prothorax with a strong longitudinal carina ...	*carinaticollis*, n. sp.
kk. Prothorax without such a carina	*reichei*, Spin.

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(7) Kuwert, Ann. Soc. Ent. Belg., 1894, p. 456.

jj. Club of antennae pale.
l. Antennae entirely pale ... *simplex*, Newm.
ll. First eight joints of antennae dark .. .. *intricata*, Klug.
ii. Apex of elytra deeply punctured and not glistening.
m. Prothorax with a longitudinal carina ... . *illaetabilis*, n. sp.
mm. Prothorax without such a carina.
n. Apical joint of antennae lightly emarginate.
o. Prothorax with strong transverse wrinkles ... *margaritacea*, n. sp.
oo. Prothorax without such wrinkles .. .. *viridis*, Guér.
nn. Apical joint of antennae deeply emarginate ... *robusta*, n. sp.
ff. Apical joint of antennae not emarginate.
p. Colour of prothorax same as elytra ... ... *brevicornis*, Chev.
pp. Colour of prothorax not same as elytra ... ... *amoena*, n. sp.
BB. Punctures on disc of prothorax not transversely wrinkled.
C. Apical joint of antennae distinctly emarginate.
q. Prothorax with two fasciae of pale hairs ... . *excavata*, Westw.
qq. Prothorax without such fasciae.
r. Emargination of apical joint of antennae at apex.
s. Colour emerald-green ... ... *aulicodes*, Gorh.
ss. Colour deep violet ... ... *reticulata*, n. sp.
rr. Emargination of apical joint of antennae at side.
t. Prothorax longer than wide *parallela*, n. sp.
tt. Prothorax not longer than wide ... ... *spinicornis*, n. sp.
CC. Apical joint of antennae not distinctly emarginate.
D. Parts of antennae pale.
u. Punctures on elytra comparatively large.
v. Prothorax strongly flattened on disc ... ... *angularis*, n. sp.
vv. Prothorax almost globular *globicollis*, n. sp.
uu. Punctures on elytra comparatively small.
w. Head and prothorax without median carina ... ... *latipennis*, n. sp.
ww. Head and prothorax with median carina ... ... *perplexa*, n. sp.
DD. Antennae entirely dark.
E. Prothorax with submedian fascia of pale hairs ... ... *hirticollis*, n. sp.
EE. Prothorax without such fascia *cribrata*, Schenk.

ELEALE PULCHRA, Newm.

This is a variable species; three specimens from New South Wales differ from the typical form, two having nearly the whole of the apical nitid portion of the elytra flavous, and the other only slightly diluted with yellow at the apex; a specimen from Kangaroo Island has the antennae somewhat darker, almost red, with the tibiae reddish (in parts infuscated), and the tarsi diluted with red; there are three specimens, in the collection of Mr. Lea, from Western Australia, which have the antennae reddish, with the club dull black.

ELEALE PALLIDIPENNIS, n. sp

Upper-surface of head and prothorax dark olive-green with brassy reflection, palpi, antennae, and elytra testaceous, the latter infuscated near scutellum, also on humeral angles, and at apex, legs dark blue in parts with a metallic reflection; thickly clothed with short subdepressed white hairs. Under-surface shining green with brassy reflections, and somewhat thickly clothed with moderately long, depressed white hairs.

Head comparatively small, with a small round interocular depression, and with very small, round, dense punctures. Antennae reaching to middle of prothorax, club distinctly three-jointed, joints seven and eight not dilated, apical joint almost imperceptibly emarginated on the inside. *Prothorax* about as long as wide, sides evenly rounded, widest part near the middle, subapical transverse impression obsolete, subbasal one distinct; with small, round, and very dense punctures, larger than those on the head, near the apex less crowded. *Scutellum* round. *Elytra* at base a little wider and about twice as long as prothorax, sides from the base gradually narrow towards apex, with comparatively shallow and very dense punctures, which are about the same size as those on prothorax and nowhere confluent, those on the humeral angles and at apex much finer, so that these parts are more nitid than the general surface. On each elytron are to be seen three more or less distinct carinae. *Legs* comparatively long and robust, posterior femora nearly reaching apex of elytra. Length, 5-6 mm.

Hab.—South Australia: Oodnadatta (Blackburn's collection); Western Australia: Cue (H. W. Brown). Type, I. 12825, in South Australian Museum.

The dark part at the base of the elytra is in the form of an inverted triangle, the basal angles of which are situated about midway between the humeral and sutural angles and the apical one on the suture below the scutellum. This dark patch is in the nature of a stain, with here and there the testaceous colour of the elytra showing through it, on two specimens this basal stain is much lighter and on one of them barely perceptible. The front tarsi and apex of front tibiae are sometimes diluted with yellow. Differs from *E. apicalis*, Macl., in being much smaller and more hairy, colour of elytra paler, joints seven and eight of antennae not dilated, punctures very much smaller, and those on the prothorax not transversely confluent.

ELEALE CARINATICOLLIS, n. sp.

Shining black, in parts reflecting blue; first three joints of antennae red. Upper-surface clothed with long, straggling, black hairs, thicker and more upright on the head and prothorax than on the elytra, scutellum with thick white pubescence, legs with black, interspersed with white hairs; under-surface with white hairs, thicker at the sides than elsewhere

Head wide, with a large interocular depression; punctures on top moderately large and distinct, becoming smaller and more crowded between the eyes and forepart, and confluent in such a way as to form a more or less distinct longitudinal carina midway between the eyes, extending from the clypeal suture nearly to the vertex. Antennae with five-jointed club, joints seven to ten obconical and gradually increasing in width, the apical on the inside obliquely, but not deeply, emarginate, the apex of emargination obtuse. *Prothorax* about as wide as long, with transverse subapical and subbasal impressions, sides strongly inflated near the middle, the disc with a large moderately deep elliptical depression, divided longitudinally by a distinct carina; near apex with fine, transverse, rugose punctures, the disc and sides with large, coarse, transverse rugosities. *Scutellum* round. *Elytra* elongate, at base wider than prothorax, depressed between the humeral angles and behind scutellum, sides very slightly constricted near middle; punctures large, deep, and reticulate, smaller and more individually distinct at the base, confluent at suture and margins near the middle, and decreasing in size towards apex, at which they are almost obsolete; on each elytron are to be seen three more or less distinct carinae. Posterior *femora* comparatively slender and not reaching to the apex of elytra. Length, 10 mm.

Hab.—South Australia: Quorn (A. H. Elston) Type (unique), in author's collection.

This species is easily distinguished by the singular sculpture of its prothorax, the elliptical depression extends from the subapical to the subbasal impressions, and is truncate at its apex and base, the longitudinal carina extends the whole length of the depression, with distinct wrinkles branching from each side of it. The punctures on the humeral angles and at the apex are almost obsolete, so that these portions are more nitid than the rest of the surface. In general appearance it somewhat resembles *E. intricata*, Klug., from which it can be distinguished by having the club of the antennae black, with the apical joint more obliquely emarginate, the sculpture of the prothorax, and the punctures on the elytra more reticulate. It differs from *E. reichei*, Spin., in the shape of the apical joint of the antennae, the sculpture of the prothorax, and the punctures on the elytra being somewhat smaller.

ELEALE ILLAETABILIS, n. sp.

Upper-surface of a bronze colour with a coppery gloss, palpi and four apical joints of club of antennae dull black, legs violet with a coppery reflection; clothing moderately dense; on head, prothorax, and legs with comparatively long, on elytra short, semi-erect, black hairs; on face and legs dark hairs interspersed with pale ones, scutellum scantily clothed with white pubescence, and at apex of elytra a small fringe of white hairs. Under-surface dark shining blue with here and there a brassy reflection, and thickly clothed with long, shaggy, white hairs.

Head moderately elongate, with three small shallow depressions, one midway between the eyes, and one near the base of each antenna, with dense moderately large punctures, only here and there confluent, those at the top less crowded. Antennae long and stout, reaching back almost to base of prothorax, joints three to six slightly longer than wide, fifth and sixth feebly obconical in shape, seventh slightly flattened and obconical, eight to eleven compressed, eight to ten obconical, the apical joint only slightly larger than the tenth, and on the inside with a small, deep, and somewhat oblique emargination, the apex of which is acute. *Prothorax* distinctly longer than wide, sides almost straight to beyond the middle, where they are slightly dilated, then contracted towards base, subapical transverse impression almost obsolete, the subbasal one comparatively shallow, disc flattened, with a small shallow fovea in the middle and just in front of the subbasal impression; densely punctured, punctures not much larger than those on head and transversely confluent, those near the apex smaller and less crowded; in the middle is a longitudinal carina. *Scutellum* comparatively small and round. *Elytra* at base about one and a half times as wide, and more than three times as long as prothorax, sides straight and parallel, gently rounded off towards apex, humeral angles slightly salient, with interhumeral and post-scutellar depressions; closely punctured, the punctures larger than those on prothorax, reticulate, here and there slightly confluent, and extending right to apex, where they are smaller but nevertheless distinct, at base less crowded and smaller, only humeral angles glistening through paucity of punctures; on each elytron are to be seen three more or less distinct carinae. *Legs* comparatively slender, posterior femora only reaching about half-way to apex of elytra. Length, 9·5-12·5 mm.

Hab.—South Australia: Mount Lofty Ranges (Blackburn's collection, Rev. A. P. Burgess, A. H. Elston), Sandy Creek (J. G. O. Tepper), Victoria: Lake's Entrance, Noble Park (F. E. Wilson), Dividing Range (Blackburn's collection); Tasmania (A. Simson). Type, in author's collection; cotype, I. 12816, in South Australian Museum.

A very elongate species, and does not vary much in colour except that on some specimens the coppery gloss is a little brighter than on others. In general appearance very close to *E. aspera*, Newm., from which it can be distinguished by the shape of the prothorax, the punctures of which are larger and more individually distinct, the transverse wrinkles coarser and less crowded, and the punctures on the elytra larger, and somewhat less crowded.

ELEALE MARGARITACEA, n. sp.

Upper-surface dark green, iridescent, palpi and club of antennae black; very scantily clothed with moderately long, semi-erect, black hairs, interspersed with white ones, which are more numerous at the sides of prothorax and on legs than elsewhere, scutellum lightly clothed with white pubescence. Under-surface shining, gula bright blue, sterna and abdomen green, the sterna with metallic, the latter with glistening brassy reflections, clothed with moderately long whitish hairs, middle portion of metasternum and abdomen glabrous.

Head elongate, with a large shallow depression between the eyes, closely punctured, the punctures round, deep, here and there confluent, and defining a longitudinal carina midway between the eyes, extending from the clypeal suture to the vertex. Antennae reaching to beyond the middle of the prothorax, the first joint very large, the second almost globular, three to six longer than wide and subcylindrical, seven and eight slightly flattened and dilated at their apices, nine to eleven compressed, the ninth nearly twice the size of the eighth, the apical not much larger than the tenth, and with a small, rather shallow, oblique emargination on the inside, the apex truncate. *Prothorax* not much longer than wide, sides slightly rounded at middle, with a shallow transverse subapical impression and a deeper subbasal one; on each side near the middle is a small, shallow fovea, disc lightly flattened, the punctures dense, large, deep, and transversely rugose, those near the apex smaller, less crowded, and more individually distinct. *Scutellum* comparatively small and somewhat transverse. *Elytra* at base about one and a half times as wide, and slightly more than three times as long as the prothorax, sides straight and almost parallel, gently rounded towards apex, humeral angles barely salient, with interhumeral and post-scutellar depressions; somewhat densely punctured, the punctures moderately large, deep, and reticulate, here and there on the middle transversely confluent, near base smaller and less crowded, those near apex smaller but just as crowded and deep as on the middle; on each elytron are three more or less distinct longitudinal carinae. Posterior *femora* not reaching to apex of elytra. Length, 10·5-12 mm.

Hab.—Western Australia: Eyre Sand Patch (W. Graham). Type, I. 12828, in South Australian Museum.

Very closely resembles *E. viridis*, Guerin, from which it can be distinguished by its colour and scantier clothing, more elongate form, prothorax more transversely wrinkled, and punctures on elytra somewhat larger. In general appearance somewhat resembles the previous species, but differs in being a lighter colour, less hairy, and by not having a small fringe of white hairs at apex of elytra, sides of prothorax more rounded, prothorax more coarsely wrinkled, and punctures on elytra somewhat larger.

ELEALE VIRIDIS, Guerin.

Herr Schenkling (8) considers this species to be the same as *E. aspera*, Newm.; this I believe to be incorrect, the two being quite distinct from each other. The insect I have identified as *viridis* differs from *aspera*, *inter alia*, by having the punctures much larger and coarser on the elytra and prothorax, particularly on the latter, which is also less elongate, and with the sides rounded near the middle; the colour is also of a much brighter green than any specimen I have yet seen of *aspera*.

Hab.—Western Australia.

ELEALE ROBUSTA, n. sp.

Upper-surface shining green with brassy reflection, palpi, antennae, and tarsi black; head and prothorax thickly, elytra scantily clothed with moderately long, upright, black hairs; face, scutellum, and legs lightly clothed with white hairs. Under-surface shining green with brassy reflections, and thickly clothed with long, shaggy, white hairs.

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(8) Schenkling, Deut. Ent. Zeit., 1906, p. 288.

Head elongate, surface of face uneven, having a moderately large and irregularly shaped shallow depression between the eyes, and a smaller and deeper one at the base of each antenna, with comparatively small and rugose punctures, those on the vertex somewhat finer and less crowded; midway between the eyes a more or less distinct longitudinal carina. Antennae long, almost reaching back to base of prothorax; joints three to six cylindrical, seven to nine obconical and gradually increasing in width, the apical joint slightly wider than the tenth, and about one a half times as large, on the inside is a large, deep, crescent-shaped emargination. *Prothorax* only very slightly longer than wide, sides gradually widening to beyond the middle, where they reach their maximum width, then suddenly contract towards the base, with a shallow subapical transverse impression and a deeper subbasal one; on the middle of disc are two shallow foveae, one just behind the subapical and the other in front of the subbasal impressions, both foveae touching the impressions, also two shallow foveae, one on each side where the sides of prothorax attain their maximum width; transversely wrinkled, the punctures, which are about the same size as those on head, are only with difficulty to be here and there separately perceived. *Scutellum* comparatively small and round. *Elytra* at base about one and a half times as wide as the widest part of prothorax and barely three times its length, sides straight and parallel to beyond the middle then gradually rounded off towards apex, humeral angles salient, interhumeral and post-scutellar depressions moderately deep; closely punctured, the punctures large, deep, quadratic, and reticulate, in places transversely confluent, those near the base less crowded and more individually distinct, only the outside of humeral angles glistening from the paucity of punctures; on each elytron are two rather indistinct longitudinal carinae. *Femora* robust, posterior ones not reaching apex of elytra. Length, 6-7 mm.

Hab.—Queensland: Stradbroke Island (H. Hacker, H. Pottinger). Type, in author's collection; cotypes, in South Australian Museum (I. 12824) and Queensland Museum.

A robust species and apparently not variable, except that some specimens have a little stronger brassy reflection than others. Although the whole upper-surface is shining, it nowhere glistens through the paucity of punctures, except at the humeral angles; the punctures at apex of elytra, although smaller than those on disc, are nevertheless distinct and deep. It differs from *E. margaritacea*, n. sp., by having a more shining appearance, brighter colour, surface of face more uneven, joints comprising the club of antennae not compressed, the apical joint bigger and more largely and deeply excavated, transverse wrinkles on prothorax more numerous and finer, and the punctures on the elytra more confluent.

ELEALE AMOENA, n. sp.

Upper-surface shining, head and elytra green, the latter tinged near suture with violet, prothorax brassy, base slightly tinged with violet, legs deep metallic-green with coppery gloss, antennae testaceous, club more or less infuscate; clothed with moderately long, almost upright dark hairs, shorter and more depressed on elytra, with pale hairs at sides, on scutellum and legs. Under-surface shining green with brassy reflections, and lightly clothed with moderately long white hairs.

Head elongate, with a small, round, interocular depression, closely and rugosely punctured, the punctures much fainter on part of face near clypeal suture, this part, which glistens, extends upwards in the form of a triangle, the apex being just below the depression. Antennae short, barely reaching to middle of prothorax; club distinctly three-jointed, the apical joint not emarginate. *Prothorax* slightly longer than wide, disc slightly flattened, sides parallel, but contracted suddenly near the base, with a transverse sub-basal impression, which has a small round median fovea in front of, and touching it; punctures at apex slightly smaller than those on head, and more or less individually distinct, those on the disc and sides much larger and deeper, transversely rugose, and arranged so as to define a narrow longitudinal median carina. *Scutellum* small and round. *Elytra* at base wider than prothorax, sides widest just beyond the middle, humeral callosities small and barely salient, interhumeral depression small and shallow, the post-scutellar depression somewhat larger and deeper; with moderately large, seriate and reticulate punctures, more or less quadratic and slightly confluent at suture near the middle. *Metasternum* and abdomen with a long, narrow, longitudinal furrow, extending from behind the intermediate coxae to almost the apex of the abdomen, and interrupted by the posterior coxae. *Femora* robust, posterior ones not reaching apex of elytra. Length, 5-6 mm.

Hab.—South Australia: Barossa (R. J. Burton), Murray River (A. H. Elston). Type, in author's collection; cotype, I. 12818, in South Australian Museum.

This is a very pretty little insect which varies slightly in colour, on some specimens the club of the antennae is darker than on the type, the prothorax is sometimes coppery, and the elytra almost blue, the humeral callosities are sometimes almost flat and the interhumeral depressions barely perceptible. Comes very close to *E. brevicornis*, Chev., from which it may be readily distinguished by its colour, somewhat finer punctuation, particularly on the prothorax, the sides of which are straighter, and also on the humeral angles and at apex of elytra, so that these parts are more nitid than the rest of surface. Differs from the description of *E. brevis*, Gorh., by its colour and size, head closely punctured, and sides of the prothorax straight.

ELEALE AULICODES, Gorham.

Specimens from Lake Callabonna differ from the typical form in being smaller, and in colour ranging from a beautiful pale blue to a deeper blue reflecting purple.

ELEALE RETICULATA, n. sp.

Upper-surface deep violet, in parts reflecting blue and green, club of antennae dull black, femora blue; clothed with moderately long black hairs, becoming shorter and more depressed towards apex of elytra, scutellum with thick white pubescence, sides of prothorax and base of femora with shaggy white hairs. Under-surface shining blue, in parts reflecting green, densely clothed with long, shaggy, white hairs, becoming shorter and more depressed on the abdomen.

Head elongate, with a large, shallow, interocular depression, moderately large punctures, becoming smaller, more crowded, and confluent between the eyes and on the forepart, and defining a more or less distinct longitudinal carina midway between the eyes. Antennae reaching to about the middle of prothorax, joints seven and eight only very slightly obconical and about as wide as the sixth, club wide and three-jointed, joints compressed, the apical truncate and emarginate at its apex. *Prothorax* slightly longer than wide, sides inflated near the middle, with a transverse subapical and subbasal impression, the former being almost obsolete, disc flat, punctures near apex small but distinct, elsewhere much larger and in places confluent, especially on disc, where they define a more or less distinct, thin, longitudinal median carina. *Scutellum* moderately large and round. *Elytra* elongate, at base wider than prothorax, sides subparallel, with interhumeral and post-scutellar depressions; punctures moderately large, crowded, and reticulate, those at the base and apex smaller, but nevertheless distinct. *Femora* moderately robust, the posterior ones not reaching apex of elytra. Length, 9-12 mm.

Hab.—South Australia. Karoonda (G E. H. Wright); Western Australia Geraldton (J. Clark), Mullewa (Miss J. F. May). Type, in author's collection; cotype, I. 12817, in South Australian Museum.

On some specimens can be seen three feeble carinae on each elytron, the elytral punctures are very crowded, but nowhere confluent, the humeral angles only glistening through paucity of punctures. Differs from *E. aulicodes*, Gorham, in having the head and prothorax more elongate, the punctures on face more crowded, the club more distinctly three-jointed, and by its colour. In general appearance it somewhat resembles *E. cribrata*, Schenk., from which it differs in being more robust and hairy, by the club of antennae, the apical joint of which is emarginate at its apex, punctures on prothorax smaller and in places confluent, punctures on elytra somewhat smaller and more crowded.

ELEALE PARALLELA, n. sp.

Upper-surface green, joints one to six of antennae metallic-green, seven to ten reddish-brown, the apical black; clothed with nearly upright, moderately long, black hairs, face, scutellum and legs with white hairs. Under-surface shining, greenish-blue, clothed with long, shaggy, white hairs, thicker at the sides than elsewhere.

Head elongate, with a small shallow depression between the eyes and a somewhat deeper one at the base of each antenna, punctures small, moderately deep and crowded, here and there confluent. Antennae long, almost reaching to base of prothorax, joints three to six cylindrical, seven and eight obconical, nine and ten wider than long and almost semicircular, apical joint nearly as large as nine and ten combined, with a large, deep, crescent-shaped emargination. *Prothorax* nearly one and a half times as long as wide, sides straight and parallel nearly to base, then slightly contracted to the base itself, disc lightly flattened, transverse subapical impression obsolete, the subbasal one almost imperceptible; punctures at apex about the same size as those on head and in places transversely confluent, those on disc and sides larger and deeper, here and there confluent, and defining an interrupted, longitudinal, median carina. *Scutellum* small and round. *Elytra* at base not much wider, and about thrice as long as prothorax, sides straight and parallel nearly to apex, then rounded off, humeral angles not salient, interhumeral depression almost obsolete, post-scutellar depression much deeper; punctures moderately large and deep, crowded, reticulate, transversely confluent near suture; at base, on humeral angles, and at apex the punctures are smaller, but not sufficiently fine to cause these parts to glisten. When viewed in a slanting direction from the front, two longitudinal carinae are to be plainly seen on the basal half of each elytron. *Legs* slender, posterior femora not reaching apex of elytra. Length, 8-10 mm.

Hab.—Queensland: Stradbroke Island (H. Hacker), Brisbane (F. E. Wilson). Type, in author's collection; cotypes, in South Australian Museum (I. 12823), and in Queensland Museum.

A very elongate and distinct species, apparently not a variable one. In general appearance somewhat resembles *E. aspera*, Newm., from which it can be readily distinguished by the apical joint of the antennae being larger and more deeply excavated, and the different sculpture of the prothorax.

ELEALE SPINICORNIS, n. sp,

Upper-surface deep blue, almost black, with here and there a metallic reflection, head paler, club of antennae testaceous; scantily clothed with rather long, semi-erect, black hairs, and thickly clothed with short, depressed, hoary hairs. Under-surface green with brassy reflections, and thickly clothed with moderately long, shaggy, white hairs.

Head with a large shallow depression between the eyes, and moderatly large punctures, not crowded, here and there confluent. Antennae long, almost reaching to base of prothorax, joints three to eight longer than wide and nearly cylindrical, club distinctly three-jointed, compressed, with the first two obconical, the apical rounded at its base, and with a large, deep, semi-oblique emargination on each side of it, that on the inner side being somewhat deeper, the apex produced into a rather long, pointed spine. *Prothorax* about as long as wide, sides evenly rounded, widest part being near the middle, subapical transverse impression entirely absent, the subbasal one very indistinct, disc very lightly flattened; punctures moderately large, but not deep, those near apex smaller, here and there confluent, with a more or less distinct longitudinal median carina. *Scutellum* small and round. *Elytra* at base little wider than widest part of prothorax and about thrice its length, sides almost straight and gently rounded towards apex; punctures smaller than those on disc of prothorax, round, shallow, and crowded, near base smaller and less crowded, only humeral angles glistening through paucity of punctures. Posterior *femora* not reaching apex of elytra. Length, 4·5-7 mm.

Hab. —South Australia: Mount Lofty Ranges (Rev. A. P Burgess), Quorn (Blackburn's collection). Type, I. 12826, in South Australian Museum

A very hairy species, and at once distinguished from all previously described ones by the singular formation of the apical joint of the antennae, the excavations on each side of it are deep, and extend for about half the length of the joint, so that the apical spine is about as long as the unexcavated portion; on some specimens the club is a little darker than on the type, but this may be due to age or post-mortem change. There is an entire absence of carinae on the elytra, which are closely and uniformly punctured, the interhumeral and post-scutellar depressions are distinct and about the same size.

ELEALE ANGULARIS, n. sp

Upper-surface shining, dark blue with metallic reflections, legs paler, antennae shining red with club dull black; scantily clothed with moderately long, semi-erect, black hairs; scutellum, sides near base of prothorax, and apex of elytra with white hairs. Under-surface dark blue with here and there metallic reflections; scantily clothed with comparatively short, depressed, white hairs, clothing much thicker at sides of pro- and mesosternum than elsewhere.

Head moderately elongate, with a large round depression between the eyes, and with small, round, rather deep, and dense punctures, here and there confluent. Antennae reaching to about middle of prothorax, joints three to five longer than wide, the third being the longest, the sixth barely longer than wide, the seventh and eighth obconical, the latter wider, the club three-jointed and compressed, the ninth and tenth obconical, the ninth about twice the size of the eighth, the apical joint about half as big again as the tenth, truncate at its apex, the inside almost imperceptibly emarginated, the inside apical angle acute, the outside one rounded. *Prothorax* not much longer than wide, sides almost straight and slightly diverging outwards to beyond the middle, then suddenly contracting towards the base, making an obtuse angle on each side; with a shallow subapical transverse impression and a deeper subbasal one, disc flattened and slightly uneven; punctures large, deep and crowded, here and there confluent, those near the apex and base smaller and less crowded; with a more or less distinct longitudinal median carina. *Scutellum* round. *Elytra* at base about one and a half times as wide, and nearly three times as long as the prothorax, sides almost straight and gently rounded off towards apex, humeral angles prominent, with interhumeral and post-scutellar depressions conspicuous; punctures somewhat crowded, large, deep, and reticulate, those at base smaller and less crowded, those on humeral angles and at apex almost obsolete, so that these parts are more nitid than rest of surface; with two more or less distinct carinae on each elytron. *Femora* robust, posterior ones not reaching apex of elytra. Length, 9·5-10·5 mm.

Hab.—South Australia: Mount Lofty Ranges (A. H. Elston); Victoria: Kiata (F. E. Wilson). Type, in author's collection; cotype, I. 12827, in South Australian Museum.

A very robust and angular species, which may be easily distinguished by the shape of prothorax and the angular appearance at base of elytra. Somewhat resembles *E. latipennis*, n. sp., from which it differs in the shape and sculpture of the prothorax, elytra proportionately longer and with larger and deeper punctures.

ELEALE GLOBICOLLIS, n. sp.

Upper-surface bright cupreous, face, sides of prothorax, and base of elytra slightly diluted with green, large patch on middle of each elytron much paler, almost testaceous, labrum and mandibles dark brown, palpi, tibiae and tarsi testaceous, the two latter infuscate in parts, femora violet; scantily clothed with short subdepressed black, interspersed with white hairs, the latter more numerous and longer at sides of prothorax, on elytra and legs; scutellum with thick white pubescence and at apex of elytra a fringe of white hairs. Under-surface violet with brilliant coppery gloss; sides of meso- and metasternum thickly clothed with moderately long, depressed, white hairs, elsewhere much more scantily clothed.

Head with a small, round, moderately shallow, interocular depression; punctures on top small and deep, confluent on the vertex and defining a small longitudinal carina, those on the face larger and somewhat obliquely confluent. Antennae barely reaching to middle of prothorax, the seventh joint almost cylindrical, the eighth slightly dilated and flattened, the club distinctly three-jointed and compressed, the ninth obconical, the tenth wider than long, the apical about as long as wide, truncate at its apex, and almost imperceptibly emarginated. *Prothorax* slightly longer than wide, sides dilated near the middle, with transverse subapical and subbasal depressions, the latter much deeper than the former, disc very lightly flattened, punctures at apex about same size as those on vertex of head and transversely confluent, on the disc and sides the punctures are much larger, deeper, and reticulate, only confluent in places near the middle, and defining an interrupted and more or less distinct longitudinal median carina. *Scutellum* round. *Elytra* at base about twice as wide as the prothorax, and a little more than twice its length, sides very slightly diminishing in width from the base to apex, which is rounded, interhumeral and post-scutellar depressions shallow; closely punctured, the punctures large, deep, reticulate, and subquadratic, here and there confluent on the middle, somewhat less crowded near base but not much smaller, on the humeral angles and at apex the punctures are almost obsolete, so that these parts are more nitid than the general surface. *Legs* moderately long, posterior femora nearly reaching apex of elytra. Length, 6-7 mm.

Hab.—Western Australia: Lake Austin (H. W. Brown); South Australia: Oodnadatta (Blackburn's collection), Murray River (A. H. Elston). Type, I. 12821, in South Australian Museum.

There are only three specimens of this species before me; the type is from Western Australia, that from Oodnadatta differs in having the club of the antennae slightly infuscated and the tibiae and tarsi darker, and the one from the Murray River is doubtfully regarded as a variety, it being more robust, its colour a bright violet with club of antennae black, but in sculpture agrees very well with the other two. In shape somewhat near *E. brevicornis*, Chev., from which it may be distinguished by its colour, the prothorax more globular, base of elytra wider, and punctures on elytra much larger.

ELEALE LATIPENNIS, n. sp.

Upper-surface somewhat shining, front of head and anterior femora green, antennae red (club excepted, which is black), palpi black, remainder violet, in parts with a coppery or metallic-green gloss; clothed with moderately long, subdepressed, black hairs, interspersed with shorter and more depressed white ones, sides of prothorax, scutellum, and apex of elytra more densely clothed with white hairs. Under-surface glistening blue, with brassy reflections on abdomen, clothed with moderately dense, shaggy, white hairs.

Head comparatively small, with a shallow interocular depression, punctures small and fairly deep, crowded, and confluent in places between the eyes, but not defining a longitudinal carina. Antennae short, barely reaching to middle of prothorax, joints seven and eight scarcely flattened or dilated, club distinctly three-jointed, apical joint almost imperceptibly emarginated on the inner side with its apex pointed. *Prothorax* distinctly longer than wide, sides almost parallel to beyond the middle, then suddenly contracted towards base, which is somewhat narrower than apex, the transverse subapical depression almost obsolete, the subbasal one distinct, the disc slightly flattened; punctures at apex slightly smaller than those on head and somewhat transversely confluent, on the disc and sides much larger and deeper, and only here and there confluent. *Scutellum* comparatively large and round. *Elytra* at base nearly twice as wide as the prothorax, and about twice its length, sides almost parallel to beyond the middle, then narrowed towards apex, interhumeral and post-scutellar depressions comparatively shallow, with moderately small punctures, crowded and reticulate, only here and there confluent, those near the base and apex smaller and less crowded, and on the humeral angles they are almost absent, so that this part is more nitid than the rest of the surface. *Legs* comparatively long, posterior femora nearly reaching apex of elytra. Length, 7-9 mm.

Hab.—South Australia: Quorn (Blackburn's collection), Murray River (R. F. Kemp and A. H. Elston). Type, in author's collection; cotype, I. 12819, in South Australian Museum.

On some specimens the colour is violet with a stronger mixture of blue in it, and on one the metallic green gloss predominates over the violet. On the middle of each elytron are two more or less distinct longitudinal carinae, starting near the base and becoming obsolete behind the middle, the apices are decorated with a fringe of moderately long white hairs. The shape of the prothorax somewhat resembles that of *E. cribrata*, Schenklg., otherwise it cannot readily be associated with any other previously described species.

ELEALE PERPLEXA, n. sp.

Upper-surface of head and prothorax green, palpi and antennae testaceous, with the club of the latter and the apices of the former lightly infuscate, elytra cupreous with a brassy reflection, anterior legs green with brassy reflection, intermediate and posterior ones violet; clothed with short, subdepressed, black hairs, interspersed with shorter and more depressed white ones; scutellum covered with white pubescence. Under-surface green with brassy reflection, and densely clothed with long, shaggy, white hairs.

Head elongate, with a moderately large, shallow, interocular depression, and two smaller, deeper, and more elongate ones at base of antennae; the punctures small, deep, and dense, confluent in parts, and defining a short median longitudinal carina on the vertex. Antennae reaching to middle of prothorax, joints seven and eight but slightly dilated and flattened, club distinctly three-jointed, the inside of the last joint barely emarginate, the outside apical angle rounded, the inside one acute. *Prothorax* longer than wide, base about as wide as apex, sides rounded, widest part just beyond the middle, disc flattened; punctures at apex slightly smaller and more shallow than those on head and in places confluent, those on disc and sides much larger, deeper, and reticulate, only running into each other near the middle and defining a longitudinal median carina. *Scutellum* round. *Elytra* at base wider than prothorax, and about two and a half times as long, sides parallel to about three-fourths the length, then rounded off towards apex, humeral callosities moderately salient, interhumeral and post-scutellar depressions conspicuous; punctures comparatively small, crowded and reticulate, nowhere confluent, those on base, humeral callosities, and near apex shallow and less crowded, so that these parts are more nitid than the rest of the surface; on each elytron are three feeble carinae. *Legs* long and comparatively slender, posterior femora reaching to apex of elytra Length, 8-10 mm.

Hab.—South Australia · Oodnadatta (Blackburn's collection), Ooldea (A. M. Lea); Western Australia · Cue (H. W. Brown), Mullewa (Miss J. F. May). Type, I. 12820, in South Australian Museum.

This species is variable in colour, some specimens being lighter and others darker than the typical form, and on one specimen the elytra are almost green, strongly diluted with brownish-yellow, on some (including the type) the labrum has a distinct yellow spot, whilst on others it is entirely dark. Very close to the previous species, from which it may be distinguished by its somewhat more elongate form, antennae and palpi paler, disc of prothorax flatter, and the longitudinal carinae on head and prothorax.

ELEALE HIRTICOLLIS, n. sp.

Head, prothorax, and legs violet, palpi and first eight joints of antennae shining black, club dull black, base and apex of elytra blue, reflecting violet, remainder of elytra green; clothed with nearly upright black hairs, long on prothorax and base of elytra and becoming shorter towards apex of the latter, scutellum thickly covered with short, depressed, white hairs, a wide fascia across middle of prothorax, and legs (particularly at base of femora) with long, shaggy, white hairs. Under-surface shining, head and thorax violet, abdomen green; scantily clothed with moderately long, subdepressed, white hairs, which are more numerous on the forepart and sides of the metasternum than elsewhere.

Head moderately elongate, with a shallow depression between the eyes and, a somewhat deeper one at the base of each antenna, punctures on top of head small, round, shallow, and slightly confluent, elsewhere much larger, deeper, and not confluent. Antennae long, nearly reaching to base of prothorax, first joint about as long as the third and twice as thick, the second is the smallest and beadlike, three to five cylindrical, seven and eight slightly, nine and ten strongly, obconical in shape; the apical joint is not emarginate, apex truncate, the outside apical angle rounded, the inside one acute. *Prothorax* about as wide as long, sides dilated near middle, anterior transverse impression almost obsolete, the sub-basal one distinct, disc with a large longitudinal, moderately deep, and elliptical depression; punctures at apex about same size as those on vertex of head and transversely confluent, elsewhere much larger and deeper, here and there confluent, and defining a distinct longitudinal carina dividing the depression in the middle. *Scutellum* round. Elytra at base about one and a half times as wide and about two and a half times as long as the prothorax, sides slightly diminishing in width towards apex, interhumeral and post-scutellar depressions moderately deep, humeral angles salient, punctures large, quadratic, reticulate, and nowhere confluent, those at base, on humeral angles, and at apex much smaller and more scattered, so that these parts are more nitid than the rest of the surface. *Legs* robust, posterior femora not reaching apex of elytra. Length, 6-13 mm.

Hab.—Western Australia: Ankertell (H. W. Brown), Beverley (F. H. du Boulay), Cue (H. W. Brown), Geraldton (J. Clark), Mullewa (Miss J. F. May), Mount Squires (Elder Expedition); South Australia: Lake Callabonna (A. Zietz). Type, in author's collection; cotype, I. 12822, in South Australian Museum.

This is a very pretty and variable species, particularly in size; on some specimens the head and prothorax are much darker in colour, a very deep blue, and on others violet tinged with green. It was this species that Blackburn doubtfully identified as *E. reichei*, Spin., from which it can be distinguished by its colour, the apical joint of antennae *not* emarginate, the punctures on prothorax more individually distinct, median fascia of white hairs on the prothorax, and the punctures on the elytra smaller, more crowded, and more reticulate. In general appearance it somewhat resembles *E. excavata*, Westw., from which it differs in being of a brighter colour, the club of the antennae composed of only three joints, and the apical one not emarginate, the disc of the prothorax depressed, only one transverse fascia of hairs on prothorax, and that extending across the middle, and the base and apex of elytra glistening.

ELEALE CRIBRATA.(9) Schenklg.

Mr. F. E. Wilson has sent me from Kiata, Victoria, several specimens which agree very well with the description of this species, except that the whole upper-surface is blue-black, with here and there a coppery reflection: four specimens with the typical colouring have been taken at Lucindale, South Australia.

ALLELIDEA SIMILIS, n. sp.

Black; antennae (club infuscated) and parts of legs pale testaceous; elytra with two white fasciae, one basal and the other submedian; scutellum black. With sparse subdepressed white setae, longer and more numerous on sides and legs.

Head wider than prothorax, with moderately large punctures; these are separate and distinct on top of head, but are crowded together on the forepart, and running into each other in such a way as to form a more or less distinct, longitudinal carina midway between the eyes. Antennae short. *Prothorax* longer than wide, apex wider than base, inflated near the middle and very much constricted at base, with an almost obsolete, transverse impression near apex; punctures larger than those on the head, and sparsely but evenly distributed. *Elytra* at base about as wide as base of prothorax, then gradually widening to beyond the middle, when they gently contract towards apex, which is rounded; punctures moderately large, distinct, and seriate, becoming smaller and less distinct posteriorly. *Legs* long and slender. Length, 3 mm.

Hab.—Australia; probably Queensland. Type (unique), in Queensland Museum.

On the elytra the basal fasciae are not interrupted by the suture and touch the margins, the submedian fasciae touch the margins but are interrupted by a very narrow strip at the suture; both fasciae are slightly narrower at suture than at the margins. The anterior tibiae are more or less pale, and the apices of the intermediate and posterior ones are also pale. This insect very much resembles *A. brevipennis*, Pascoe, with the elytra continued to beyond the second white part, where it is cut off on that species; it also differs in having the prothorax more closely punctured on the disc. There is a resemblance in shape to a big *A. ctenostomoides*, Waterh., but having the elytra without subapical white marking; and it is also closely associated with *A. curvifasciata*, Lea, from which it differs in having the white basal markings broader and almost parallel, and the submedian fascia broader and not shaped like a boomerang, the punctures smaller, particularly on the prothorax.

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(9) Schenkling, Deut. Ent. Mus. Mittl., 1916, p. 148.

PYLUS PYGMAEUS, Blackb.

This insect varies in the colour of prothorax and the size and shape of piceous markings on the elytra. On some specimens the prothorax is darker, and on one it is entirely piceous; on all the specimens examined by me the posterior fascia, although varying greatly in size and shape, does not extend to the extreme apex of elytra. An example from Queensland has the elytra testaceous and, in addition to the median and subapical fasciae, has the base infuscated. Widely distributed in Australia and Tasmania.

CHRYSOMELIDAE.

CLEPTOR GOUDIEI, Lea.

Several specimens of this beautiful insect were taken by R. F. Kemp and myself from the foliage of the Native Pine, *Callitris robusta*, in January, near Murray Bridge, South Australia. The male, which hitherto was unknown, is much smaller than the female and of a beautiful green with a slight brassy reflection, the under-surface more brassy than the upper, abdomen with a wide longitudinal depression down the centre, the first segment with large scattered punctures, second, third, and fourth segments rather densely punctured, in other respects it agrees very well with the author's description of the female. The female varies in colour, some of the specimens taken are of the same colour as the male, others are bright copper with a greenish reflection.

THE CRATERS AND LAKES OF MOUNT GAMBIER SOUTH AUSTRALIA.

By Charles Fenner, D.Sc.

[Read August 11, 1921.]

Plate X.

1. Introduction.
2. Discovery and Settlement of Mount Gambier.
3 Previous Literature (with list of chief references).
4 General Description:—
    - *(a)* The surrounding country.
    - *(b)* Mount Gambier.
5. The Volcanic Materials:—
    - *(a)* The lava and its extent.
    - *(b)* The fragmentary material and its distribution.
6. Age of the Eruption:—
    - *(a)* Relation to Victorian Newer Basalt period.
    - *(b)* Physiographic evidence.
    - *(c)* Fossil evidence.
7. Duration of the Eruptive and Effusive Phases.
8. The Number of Craters and the Order of Eruption:—
    - *(a)* Previous opinions.
    - *(b)* Contour Map.
    - *(c)* Reconstruction of the Cinder Cones.
        - (i.) Dip of tuff beds.
        - (ii.) Slopes of external faces.
    - *(d)* Section through the reconstructed cones, showing collapses, etc.
9. The Subsidences:—
    - *(a)* Extent, cause, and time of collapse.
    - *(b)* The Blue Lake.
    - *(c)* The Leg of Mutton Lake.
    - *(d)* The Valley Lake.
    - *(e)* Crater Lake.
    - *(f)* The Moorak Depression.
    - *(g)* The Punch-bowl.
    - *(h)* The Water of the Lakes.
10. Scenic and Economic Aspects.
11. Summary.

1. INTRODUCTION.

Mount Gambier is situated in the extreme south-eastern corner of South Australia. The volcanic features of that district, of which Mount Gambier is the most important, mark the western limits (1) of that great area of comparatively recent volcanic activity that affected the greater part of central and south-western Victoria.

The cinder cones of Mount Gambier were never large, nor is the area covered by the ash deposits of very great extent. The volcanic phase was accompanied or followed by extensive collapse of the greater part of the area covered by the cones of ejected material, so that only remnants of the original cones now mark the points of activity. The areas of the collapse are now occupied in part by deep lakes.

Several factors combine to make Mount Gambier of special interest. The fertile volcanic soils are of great economic importance, and because of them the town of Mount Gambier has grown up, and has become the chief business centre of that portion of South Australia. The "Mount," with its beautiful lakes, being the product of two series of catastrophic happenings, namely, a rapid volcanic up-building, with subsequent extensive collapse, presents scenic features of an exceptional nature and of great variety and beauty. From the scientific point of view, the structural features present special facilities for investigating the mode of origin of the present physiographic features.

The observations on which this paper is based were carried out in such leisure hours as were available during numerous visits to Mount Gambier, extending over the past five years. In this work the writer has received invaluable and enthusiastic assistance from Mr. H. C. Hosking, B.A., of Mount Gambier, to whom his best thanks are due. The writer is also indebted to Mr. L. Keith Ward, B.A., B E., Director of Mines, South Australia, for his assistance and suggestions.

2. DISCOVERY AND SETTLEMENT OF MOUNT GAMBIER

On the evening of December 2, 1800, Lieut. James Grant, on a "voyage of discovery" in the "Lady Nelson," was nearing the coast in the neighbourhood of Mount Gambier. So far the navigator had not sighted Australia, but a close watch was ordered to be kept for signs of land. The first such sign noted was the presence on board of a dragon-fly, or "horse-stinger "(2)

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(1) With the possible exception of the Kangaroo Island basalts (see "Enstatite Basalt from Kangaroo Island, South Australia," E. R. Stanley, Trans. Roy. Soc. S. Austr., vol. xxxiv., 1910, p. 69).

At 8 o'clock on the morning of December 3, Grant got his first sight of New Holland, "the part that was right ahead appearing like unconnected islands, being four in number, distant six or seven leagues." These turned out to be two capes and two high mountains a considerable distance inshore. "One of them is very like the Table Hill at the Cape of Good Hope, the other stands farther in the country. Both are covered with large trees, as is also the land, which is low and flat as far as the eye can reach. I named the first of these mountains after Captain Schank,(3) and the other Gambier's (4) Mountain." On Grant's map the two volcanic hills are drawn in outline (not merely marked in position), and are shown as covered with timber. They are quite recognizable from the drawings, and are named "Schank's Mountain" and "Gambier's Mountain." On the centenary of Grant's discovery a substantial "Centenary Tower" of red dolomite was erected on the highest point of the Mount.

Regarding the spelling of the name of Mount Schank, it may be noted that Lieut. Grant consistently uses the spelling "Schank," which has been adopted by all South Australian cartographers and surveyors. The Rev. J. E. T. Woods, throughout his "Geological Observations in South Australia" uses the spelling "Shanck." The Dictionary of National Biography, however, gives the correct spelling as "Schanck," as adopted in the name of Cape Schanck, Vict.

As would be naturally expected from the geography of the area, the Mount Gambier district was first settled from the east. It would appear that Mr. S. G. Henty, of that well-known pioneering family, was the first white man to visit Mount Gambier. Stimulated by the great inducements held out to selectors by the South Australian Government, he set out from Merino Downs (Vict.) towards the South Australian border in June, 1839.(5) He was accompanied by two men, and on the second day of their journey they arrived at Mount Gambier. He ascended a gentle slope of the Mount, probably somewhat to the west of the cemetery, and suddenly found himself confronted by the great chasm of the Blue Lake, a sight "quite beyond his powers of description." He was uncertain at the time whether Mount Gambier was in South Australia or not, and so pushed on further to the west. He afterwards formed cattle stations at the Mount. Writing in 1854 he described the district as "now thickly settled."

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(2) "The Narrative of a Voyage of Discovery performed by His Majesty's vessel, the 'Lady Nelson,' of Sixty Tons burthen," by James Grant. London, 1803.

(3) Captain John Schank (1740-1823), the "worthy and esteemed friend" of Grant. He invented the patent sliding keel with which the "Lady Nelson" was fitted.

(4) Admiral James Gambier (1756-1833), a well-known seaman, later commanded the British Fleet at Copenhagen, 1807, and was rewarded with a Peerage.

(5) "Letters from Victorian Pioneers to Governor La Trobe." Melbourne, 1899.

3. PREVIOUS LITERATURE.

1800—Reference has already been made to the record of the original discovery, of this portion of Australia, by Lieut. James Grant.

1839—The records also exist of the first man who actually visited the area, S. G. Henty, and these have been referred to. Numerous references to the locality are to be found in the records of the early settlers and in the published accounts of the aboriginal life and legends, but in these there is nothing of special geological interest.

1846—The oldest geological notes available are those published by Thomas Burr, then (1846) 'Deputy-Surveyor-General of the Province." These notes give a brief but extremely interesting account of Mount Gambier, and will be quoted from later.

1851—According to the Rev. J. E. T. Woods, Blandowski made a survey of the Mount in 1851. His observations were published in the Adelaide German paper, but his maps have been lost.

1862—In this year the Rev. J. E. T. Woods published his "Geological Observations in South Australia," of which Chapters VIII. and IX. are devoted to the volcanoes of Mounts Gambier and Schank. His observations show an extended and intimate knowledge of the area, and remain the most important account yet written.

1879—In this year Professor Ralph Tate, of the University of Adelaide, made passing reference to Mount Gambier in his Presidential Address to the Philosophical Society of Adelaide.

1884—The State Government Geologist, H. Y. L. Brown, published a short account of the area, dealing more particularly with the depth, temperature, and origin of the water in the lakes. In these notes the suggestion was first made that there had been but one crater at Mount Gambier.

1901—"Notes on the Extinct Volcanoes of Mounts Gambier and Schank" were published by Professor Howchin. In these notes were suggested special lines for further investigation, which the present writer has endeavoured to follow.

1906—J. C. Moulden published a petrographical note *re* the Mount Gambier basalt, as also had Chas. Chewings in 1894.

1907—Dr. T. S. Hall, of Melbourne, gave some account of the tuff beds, dealing more particularly with their mode of deposition.

1909—E. R. Stanley carried out detailed chemical and mineralogical examinations of the types of lava at Mount Gambier, and added to these in 1910 with special notes on the olivine bombs and nodules found in the tuff beds.

In addition numerous references are made to this area by Professor Howchin in his Geography of South Australia (1909), and in his Geology of South Australia (1918).

The following is a list of the most important books and papers dealing specially with this area. Reference is made to them throughout this paper by using the numbers attached in this list:—

1. **Burr**, Thomas—"Remarks on the Geology and Mineralogy of South Australia." Adelaide, 1846.
2. **Woods**. Rev. J. E. T.—"Geological Observations in South Australia." London, 1862.
3. **Brown**, H. Y. L.—"Report by Government Geologist on Lakes in Mount Gambier District." Parliamentary Papers, South Australia, 1884, No. 256.
4. **Howchin**, W.—"Notes on the Extinct Volcanoes of Mount Gambier and Mount Schank, South Australia." Trans. Roy. Soc. S. Austr., vol. xxv., 1901.
5. **Hall**, T. S.—"Note on the deposition of Bedded Tuffs." Proc. Roy. Soc. Vict., vol. xx., 1907.
6. **Stanley**, E. R.—"Complete Analysis of the Mount Gambier Basalt, with petrographical descriptions" Trans. Roy Soc. S. Austr., vol. xxxiii., 1909.
7. **Stanley**, E. R.—"Lherzolite and Olivine from Mount Gambier." Trans. Roy. Soc. S. Austr., vol. xxxiv., 1910.

4. GENERAL DESCRIPTION.

Mount Gambier is the best known of a series of small volcanic hills in the south-eastern corner of South Australia. These hills may be classified in three groups:—

(i.) Mount Gambier, The Bluff, Mount Muirhead, and Mount Burr.
(ii.) Mount Edwards, Mount McIntyre, and Mount Graham.
(iii.) Mount Schank.

Groups (i.) and (ii.) show a linear arrangement in a north-north-west direction, while Mount Schank stands alone to the southward. The linear direction referred to is parallel with the present coastline, with a series of past coastlines, with a rather remarkable and extensive series of consolidated dune ridges,(6) and possibly with the direction of a fault-line, running parallel to and adjoining The Bluff, Mount Muirhead, etc. This suggested fault-line has not been carefully investigated, but a casual examination suggests it as well worthy of study, from both the geological and physiographic points of view.

(a) The Surrounding Country.—The bed rock of the area consists of a series of marine tertiary limestones (Janjukian),(7) which mark the site of the ancient "Murray Gulf," and which extend over thousands of square miles to the north, west, and east of Mount Gambier. This series is, in places, from 1,800 to 2,000 ft. in depth,(8) is richly fossiliferous, and is believed to be in places underlain by the carbonaceous mudstone series of the Jurassic period; there is, however, no record of the occurrence of fragments of this formation in the ejectamenta at Mount Gambier. The limestones remain on the whole remarkably level-bedded. Their wide level surface rises gently from the sea, broken only by the series of parallel ridges referred to, by occasional low inliers of early palaeozoic and older rocks, and by one or two "breaks" which may be due to comparatively late fault-scarps.

The limestones include red and cream-coloured dolomites and a polyzoal limestone (all three used as building stones), and, in places, flints are extremely abundant. The surface is of extreme topographic youth; there is an almost complete absence of surface streams. Swamps abound, and in the winter time these overflow and unite as broad flowing sheets of water.

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(6) See reference No. 2; also referred to in various maps and reports of the Geological Survey of South Australia, *e.g.*, Bulletin No. 4, plate facing p. 25 (1915).

(7) Memoirs of the National Museum, Melbourne, No. 5, Frederick Chapman, 1914, p. 48.

(8) The Portland (Vict.) Bore penetrated these limestones to a depth of 2,265 ft. Ann. Rep. Sec. Mines, Vict., 1895, p. 60.

The rocks are in the main very porous, with abundant caverns, collapses, and "run-away holes." The limestones contain the extensive sub-artesian fresh-water basin of the miocene "Murray Gulf," the waters of which are mainly derived from local rainfall and from the rainfall in the adjoining counties of Lowan and Follett (Victoria).(9) The average rainfall at Mount Gambier itself is 30 to 35 in. Near the coast the water-table of the sub-artesian basin is cut by the land surface, and beautiful streams of fresh water emerge at such places at Ewen Ponds, Dingley Dell, and the interesting miniature mound springs near Beachport. The surface of the underground water is about 70 to 80 ft. above sea level at Mount Gambier (140 ft. above sea level), and is there exposed to view in a series of four beautiful lakes.

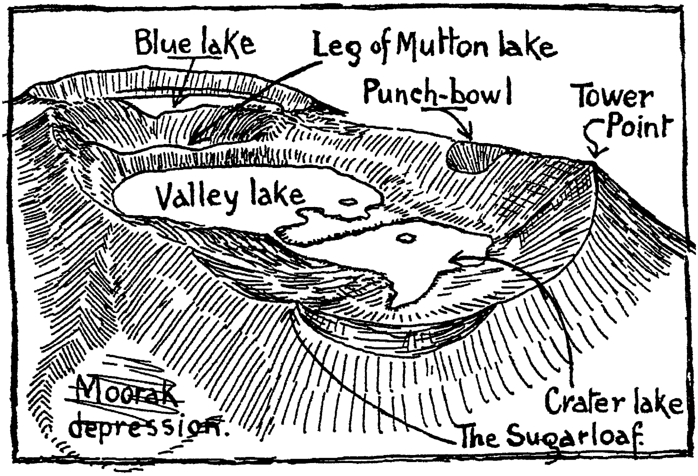

Fig. 1.
Sketch of the present-day remnants of Mount Gambier, looking E.S.E. along the line of the lakes, to show the chief features.

The limestones decompose to a red clay, and the chief modifying feature of the surface soils is the peaty accumulations of the extensive swamp areas and the sand of the ancient dune ridges. The most fertile areas are those where basaltic "ash" fragments have been deposited.

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(9) Maps submitted to First and Second Interstate Conference on Artesian Water (A. S. Kenyon), 1912 (p. 32 of report) and 1914.

(b) Mount Gambier.—The immediate neighbourhood of Mount Gambier might best be described by reference to the sketch given in fig. 1, which has been drawn in part from an aerial photograph taken by Mr. Arthur, of Mount Gambier.

The present-day "Mount Gambier," which gives its name to the town that nestles on its northern side, is but a remnant of what was at one time a considerable pile of volcanic material, mainly fragmentary. The series of cinder cones extended about 180 chains in the direction of its greatest length (roughly S.E.-N.W.), and was about 80 chains in width.

A series of extensive collapses took place along the line of the cones, so that the higher portions have almost wholly disappeared, and only the outer, lower slopes remain intact. The collapsed area is in part occupied by lakes, the surfaces of which are about 70 ft. below the level of the town and the surrounding plain. The highest point, on which stands the Centenary Tower, is about 650 ft. above sea level (about 500 ft. above the level of the town).

The area of elevation and collapse, now largely clothed by native and introduced vegetation, presents features of remarkable variety from the scenic point of view. The depressions, as shown in the sketch, are six in number:—(i.) Blue Lake; (ii.) Leg of Mutton Lake; (iii.) Valley Lake (broadly connected with iv.); (iv.) Browne or Crater Lake; (v.) the Punch-bowl; (vi.) the Moorak depression.

5. THE VOLCANIC MATERIALS.

(a) The Lava and its Extent.—In the very early stages of the volcanic outburst there was a small lava flow. This is exposed in section in the western and eastern walls of the Blue Lake, and in the eastern wall of Valley Lake, with a thin deposit of volcanic ash separating it from the underlying limestones. These sections are beautifully clear—almost diagrammatic in outline (see fig. A, pl. x.).

The basaltic lava is locally known as the "blue rock," in distinction to the beds of stratified tuff, which latter, by a curious etymological twist, is locally known as "the lava."

The lava is thickest at exposures B and C (fig. 2), thinning towards D, and doubtless flowed in the direction from A towards D. As suggested by Professor Howchin (*Ref.* No. 4), the flow probably came from a crater situated near to and eastward of the point A. At the latter place there is an interesting development, on the inner face of the wall of the Mount, of ropy and stalactitic lava.

In all the sections shown the rapid thinning out of the lava, from the centre of the stream (50 ft. thick) towards the sides, is clearly to be seen, and suggests quite a small extension to the north and south. In well-sinking, in and near the northern slopes of the Mount, the "blue rock" is sometimes met with. From all the evidence available, the maximum extent of this early flow is probably represented in the above sketch (fig. 2).

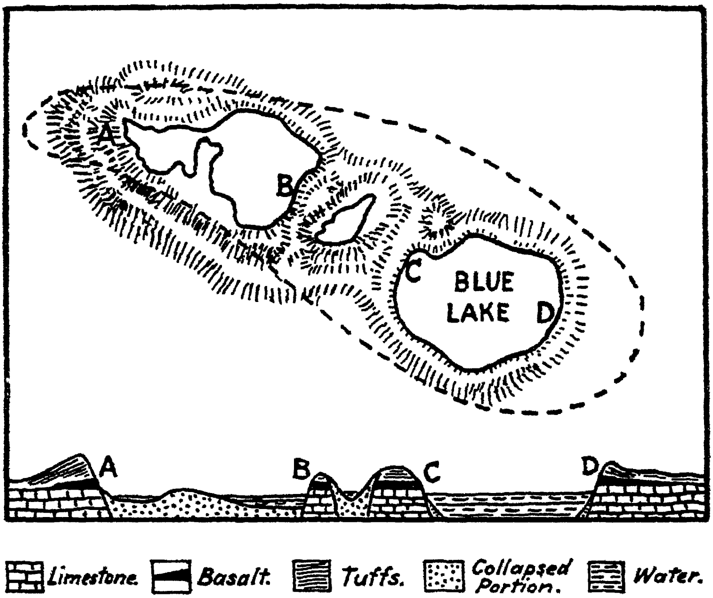

Fig. 2.
Sketch plan and section to show the probable extent of the lava flow. In the section the basalt is shown in black (not to scale).

Mr. E. R. Stanley has carried out careful analyses and microscopic examination of the lava, and also of the olivine-bearing nodules, bombs, and fragments that occur throughout the tuff deposits (*Refs.* 6 and 7). The following table shows Mr. Stanley's analysis, compared with the average analysis of typical basalts in Victoria, and with Mr. Daly's "average basalt":—

	A.	B.	C.
SiO_2	48·00	48·84	46·95
Al_2O_3	14·11	15·90	14·37
Fe_2O_3	5·61	5·23	1·37
FeO	6·11	6·30	9·52
MgO	8·81	6·38	9·74
CaO	8·68	9·15	10·04
K_2O	3·01	3·05	3·49
Na_2O	1·25	1·46	1·53
H_2O+	·73	1·60	·52
H_2O-	·80		·10
TiO_2	2·20	1·35	2·04
MnO_2	·13	·29	—
P_2O_5	·50	·45	·46
	99·94	100·00	100·13

A. Average of six basalts, Camperdown District, Victoria. "Geology of the Camperdown and Mount Elephant Districts," Mahony and Grayson, Mem. Geol. Sur. Vict., No. 9, 1910.

B. Average basalt analysis. "Igneous Rocks and their Origin," R. A. Daly, 1914, p. 315.

C. Mount Gambier vesicular olivine basalt. E. R. Stanley (*Ref.* No. 6).

Stanley also published microscopic descriptions of the slaggy and vitrophyric types of lava, found at Mount Gambier, and concludes that, on the evidence presented, the Mount Gambier lavas are closely related to those of Western Victoria. The comparison with Mahony and Grayson's analyses, and with other subsequent analyses of Victorian basalts, strongly supports this conclusion, as does other evidence later referred to.

(b) The Fragmentary Material and its Distribution. Apart from the brief effusive phase above described, the vulcanicity was wholly of the explosive type. Possibly the occurrence of the outburst in the centre of a strongly water-bearing series had some bearing on this fact. The ejectamenta of which the cinder cones were built, and of which the finer particles were widely distributed, consists of lapilli and ash with but a small representation of coarser scoriaceous material. In this respect the materials and the cones more closely resemble those of Tower Hill, in Victoria, than the more abundant scoria cones, such as Mounts Warrenheip, Buninyong, etc.

The general appearance of the stratified tuffs, in section, is quite like those of South-western Victoria and also the better known tuffs of Lake Burrumbeet, though with much less nodular basalt than the latter beds show. At Mount Gambier huge ejected blocks of limestone, dolomite, and basalt occur, with olivine bombs and blobs of ropy lava. Occasionally, also, one may find flint nodules, waterworn quartz pebbles,(10) and rare fragments of ancient rock (mica schist, etc.).

The foregoing features have been more carefully described by others, but there is no record of the exact extent of the ash deposits. With the able assistance of Mr. H. C. Hosking, the writer investigated the limits of the ash deposits, with the results shown in fig. 3. In this investigation the matter was quite easy where road and rail cuttings, quarries, and subsidences occurred; elsewhere the fertility of the soil was noted as evidence of the presence of ash, and this was corroborated by the statements of the occupiers of the land, and by shallow excavations. It is remarkable how light a layer of ash has rendered the soil fertile as compared with that of the limestone or sand-dune country, but there are also occasional areas of good land beyond the limits of the ash deposits.

On the outermost areas of the ash, the only evidence consists of small, occasional, friable, light-brown nodules that one soon becomes expert in recognizing. Such nodules were also, later, found along the railway line, to the north-west, as far as Mitchell Siding, but the deposit of ash must have been here so slight that it has not been included in the plan. Possibly one or two stiff "south-easterlies," such as occasionally occur here, would account for this light distribution to the north-west. Howchin (11) states that the ash extended seven miles in a north-easterly direction, but careful examination showed that this is not the case; the limit of the ash in a north-easterly direction is a little over two miles. The greatest extent of the ash is in a southern and south-easterly direction, and the total area affected is about 25 square miles.

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(10) These waterworn pebbles may have been carried by aborigines, whose flint flakes are abundant on certain parts of the Mount. More likely, however, they were derived from the occasional beds of sand and gravel that occur in the tertiary beds; the records of the South Australian Department of Mines show that sands and gravels were met in several bores in the Hundred of Young, at depths between 100 and 150 ft.

(11) "The Geography of South Australia," Howchin and Gregory, 1909, p. 130. I am informed by Professor Howchin that the above statement was made on the authority of the late Professor Tate, who stated that the greater extension of ash in a north-easterly direction could be explained from the prevalence of south-westerly winds.

As pointed out by Dr. T. S. Hall (*Ref.* No. 5), the stratified tuffs, away from the Mount itself, closely follow the contour of the land surface, and were undoubtedly deposited subaerially. The manner in which the beds follow the gently undulating surface of the limestones and sand-dunes is excellently shown in practically every cutting where such sections are available.

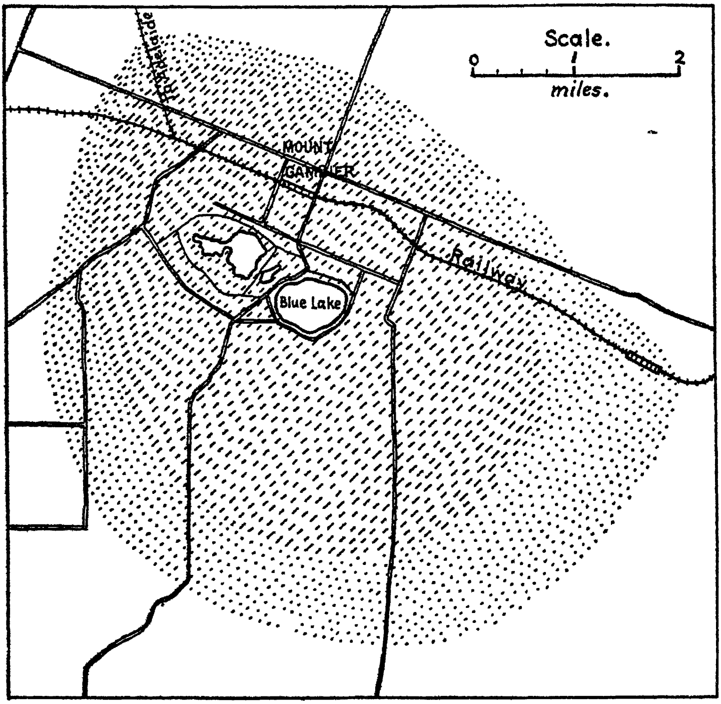

Fig. 3.

Plan showing the extent of the ash deposits surrounding Mount Gambier, covering an area of about 25 square miles.

Since there is no doubt whatever that the whole of the ash was ejected from the two or more foci at Mount Gambier, the unsymmetrical distribution of the finer material at once suggests the influence of the prevailing winds as the chief agent of its distribution.

There is every reason for assuming that the eruptions were of so recent a period that it is quite likely that the circumstances of atmospheric circulation were at that time much as they are at present. In order to get an average of the wind direction and velocities, the details of the local records for the years 1915, 1916, and 1917 were obtained by the courtesy of Mr. E. Bromley, of the South Australian Meteorological Bureau, and of the postmaster at Mount Gambier.

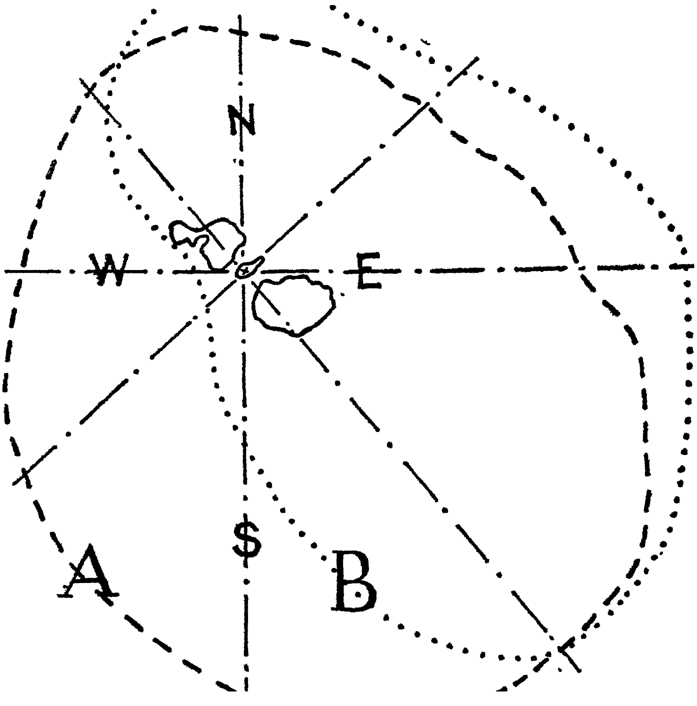

Fig. 4.
Graph showing the general outline of the ash deposits (A) compared with the present average annual wind direction and strength (B).

The direction, velocity, and continuity of these winds were graphed in various ways (by months, seasons, years, etc.), in the hope that some light might thereby be thrown on the duration of the explosive activity, or on the season of the year at which the chief eruptions took place. These efforts were not attended with any positive results, but it will be seen from fig. 4 that the average graph of the winds for the year corresponds, roughly, with the outline of the limits of the finer volcanic material, and confirms the idea that the ash distribution was governed by winds similar in direction and velocity to those of the present day.

East winds are very rare throughout the whole year, which fact corresponds with the limited distribution of the ash to the west of the craters. South-easterlies are commonest in late January and February, while north-west and west winds are strongest in September and October. The graph of the average October winds corresponds most closely with the actual distribution of the ash. The chief point of discordance is that the extent of the ash deposits to the south, towards O.B. Flat, etc., is greater than the average amount of north wind would suggest.

The question of the duration of vulcanicity is discussed later, but if it be fair to assume that the wind circulation was at that time much as it is at present, as suggested by the graph, and if it be further shown that the duration of the volcanoes' life was brief, then the foregoing results suggest that the explosive activity took place about the middle of the later half of the year.

6. Age of the Eruption.

(a) Relation to Victorian Newer Basalt Period.—Before discussing the age of the Mount Gambier vulcanicity it is desirable that its relationship should be established with the great period of eruptive and effusive vulcanicity that occurred in

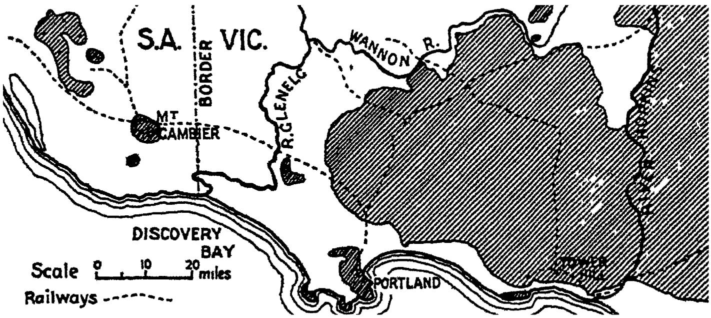

Fig. 5.

Sketch map showing the area covered by Newer Basalts in South-western Victoria, and the volcanic localities of South-eastern South Australia.

Victoria in late Tertiary times, and which is known as the Newer Basalt Period. The newer basalts, with their associated scoria and cinder cones, tuffs, etc., cover thousands of square miles of Central and South-western Victoria, and extend almost to the South Australian border.

The close relation in composition between the materials of the Victorian Newer Basalt Period and those of Mount Gambier has already been established. The relationship in space of the volcanic features of the two States is quite clear from fig. 5, and strongly suggests that the South Australian foci are outlying centres of the one great area of activity.

Professor Skeats,(12) in describing the Victorian Newer Basalts, says:—"They form the Melbourne and Keilor plains, and occur . . . over thousands of square miles in the the Western District, passing over into South Australia and connecting with the recent volcanic rocks of the Mount Gambier district."

(b) Physiographic Evidence.—One of the features stressed by those who have dealt with the denudation of cinder cones is the remarkable way in which, in some cases, these very porous beds will absorb the rainfall, lessen the "run-off," and so preserve for ages an appearance of youth. While giving full consideration to this fact, the physiographic evidence (denudation, etc.) at Mounts Gambier and Schank points to a fairly recent geological period for their age. Familiarity with the volcanic features of a considerable portion of the Newer Basalt area in Victoria suggests also that the age of the cinder cones of Mounts Gambier and Schank is about equal to, or less than, that of similar Victorian features.

On those portions of the exterior of the cones that may be unquestionably accepted as unaffected by the great collapses that have taken place, the small amount of denudation is remarkable. Wherever opportunity for testing the matter arose, the general surface slope was found to be that of the dip of the stratified material.

(c) Fossil Evidence.—In the paper previously referred to, Professor Skeats discusses the age of the Victorian Newer Basalts, on the evidence of fossil leaves and fruits, etc., and believes that the volcanic activity extended throughout a considerable period, "from the Pliocene to the Recent, if not Historic periods. . . . The tuffs about Tower Hill overlie the geologically-recent dune-limestones of that district."

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(12) "The Volcanic Rocks of Victoria," E. W. Skeats. Presidential address. Section C. A.A.A.S. 1909.

Mr. R. H. Walcott (13) has recently published an account of volcanic tuffs near Mount Terang (Vict.), where bones of extinct marsupials and an aboriginal implement were found below the tuff. Professor Gregory (14) has discussed the question of the historic age of the more recent volcanoes in his enquiry into the antiquity of man in Victoria. Chapman and Gabriel,(15) in 1917, published an account of a shell-bed underlying the tuffs of the Tower Hill series, near Warrnambool (Vict.), and concluded that the tuffs of the Tower Hill series were ejected between early Pleistocene and early Prehistoric times, and represent one of the last stages of the volcanic outburst in Victoria. The evidence at Tower Hill is particularly mentioned on account of the close lithological and physiographic resemblance of the materials and forms there to those at Mount Gambier.

In the "Geology of South Australia" (Howchin), p. 480, it is stated that "on the southern slopes of Mount Graham there are the remains of an ancient sea beach, about 40 ft. above the present level of the plain, consisting of perfectly loose sand and sea-worn shells. This shows that the sea must have encroached upon the locality and again receded since the volcanoes were in eruption." There is no evidence whatever of such an encroachment affecting the Mount Gambier area.

Professor Howchin, in his "Geology of South Australia," p. 134, says:—"Pliocene and Post-pliocene clays and soils underlie the ash-beds (at Mount Gambier, etc). The latter enclose impressions of trees and plants of species still growing in the neighbourhood, such as *Eucalyptus*, *Casuarina*, *Banksia*, etc., and extinct marsupials of the late Pliocene and Post-pliocene age." Mr. F. Chapman (16) mentions also the bracken fern *(Pteris aquilina)* as underlying the ash-beds, as does a *Banksia* "in every way comparable to *B. marginata*." I submitted to Professor Osborn, of the Adelaide University, a well-preserved impression in ash of the banksia leaves, and he could find no difference whatever between such leaves and those of the present-day *B. marginata*.

Following along the line of evidence, suggested by Professor J. W. Gregory, *re* the mention of active volcanoes in aboriginal legends, it may be mentioned, that in the recorded legends of the Mount Gambier tribes there is frequent reference to the lakes, etc., of the district, but nothing that I have read to suggest that the race had any record of an actual eruption.

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(13) The Volcanic Tuff of Perjark Marsh, Victoria, R. Henry Walcott, Proc. Roy Soc. Vict., vol. xxxii., Part I., 1919.

(14) The Antiquity of Man in Victoria, J. W. Gregory, Proc. Roy. Soc. Vict., vol. xvii., 1904.

(15) On a shell bed underlying Volcanic Tuff near Warrnambool, Chapman and Gabriel, Proc. Roy. Soc. Vict., vol. xxx., Part I., 1917.

(16) "Australasian Fossils," Frederick Chapman. 1914.

Summing up this evidence, we may conclude that Mount Gambier and its associated vents represent a western marginal outburst from the great basaltic magma that gave rise to the Victorian Newer Basalts, occurring near the close of the Newer Basalt Period, and possibly dating to quite late pre-historic time.

7. DURATION OF THE ERUPTIVE AND EFFUSIVE PHASES.

As pointed out by previous observers, the preliminary phase of the Mount Gambier volcano was an explosive one, brief in duration, as evidenced by the thin layer of ash to be seen immediately overlying the Janjukian Limestones, and underlying the basalt flow.

Following this, the lava welled up and flowed for a couple of miles or so in an easterly direction. There is no evidence to suggest that the lava belonged to a later stage of activity and was forced along in its present position as a "sill." The effusive phase, like the other features of this volcano, was on a diminutive scale, and lasted probably for a few hours only.

Subsequently the volcanic activity was wholly explosive, at times with considerable violence. In the effort to discover the probable duration of the building of the cinder cones, investigation has been made of all available descriptions of cases where the duration of activity is known, either actually or approximately. The best comparison might be made with the well-known case of Monte Nuova, near the Bay of Naples, since that particular cone, though smaller, is comparable to the chief cone at Mount Gambier in height and circumference. It will be remembered that, about 400 years ago, Monte Nuova was built up before the eyes of observers in a few days.

Mount Gambier is larger and more complex in structure, but it is clearly possible that its volcanic history was very brief. As already mentioned, effort was made to discover evidence regarding the duration of activity from comparison of the graphic records of present-day wind direction with the distribution of the ash. The evidence is admittedly of no high value, but, taken for what it is worth, it suggests that the cones were built up in the later months of the year.

It has been pointed out that cinder cones, in some cases, preserve their shape in a remarkable manner. This is particularly the case when the materials have become, to some extent, set and consolidated and covered with vegetation. In the earlier period, while the material is still merely loose fragments, the erosion of a winter should leave distinct traces. At present, for instance, the loose faces of the interior wall below the Tower are being rapidly worn away.

In noting the many sections of the stratified ash, both radial and normal to the foci, watch was kept for any signs of contemporaneous erosion. In no case was there found any suggestion of a runnel or valley formed in the ash-beds during deposition. This is suggestive of the idea that no wet season occurred during the period of explosive activity

The stratified beds are numerous, but show no consistent evidence of rhythm in deposition, though Woods (*Ref.* 2, p. 254) recognized three series of layers, varying in each series from coarser material below to finer material above. The occurrence of the numerous and varied layers is probably due to the intermittence and variation in force of the explosions, and to the shifting of the winds. Summing up the evidence as presented in the field, I would suggest as a working hypothesis that the whole period of activity at Mount Gambier was something more than, say, six weeks and less than six months.

8. THE NUMBER OF CRATERS AND THE ORDER OF ERUPTION.

(a) Previous Opinions.—The question of the number of craters that existed at Mount Gambier is one on which there has been considerable divergence of opinion, and while it is purely of theoretical and academic interest, very careful consideration has been given to this point. The opinions of previous observers are given below, as far as possible in their own words.

The earliest available account of the geology of South Australia was published by Thomas Burr, in 1846, when the Province was but ten years old, and seven years after Mount Gambier had been first visited by white men (see *Ref.* No. 1). The brief account there given of Mount Gambier was kindly brought under my notice by Mr. L. Keith Ward, the Director of Mines of South Australia.

Thomas Burr says, concerning the craters:—"This mountain has three craters, which lie in a direction nearly east and west. The western crater (17) is divided into two portions —that to the east contains a lake of great depth containing fresh water. The middle crater (18) is much smaller and circular, with a small lake at the bottom The eastern crater(19) is nearly of the same size as the western, and comprises a large lake of great depth, which cannot be visited, as there are precipitous rocks all round." This writer gives the approximate widths of the various craters, but does not mention the possibility of enlargement by subsidence. The Rev. J. E. T. Woods (see *Ref.* No 2) believed that there were five craters:—(1) The west end of the Valley Lake (now Browne or Crater Lake); (2) The east end of the Valley Lake (now Valley Lake); (3) the Centre Lake (now Leg of Mutton Lake); (4) Blue Lake; (5) the Punch-bowl (regarding this crater he was in some doubt, and did not have the evidence now available in the bare walls of this depression). Woods gives full value to the matter of enlargement of the craters by collapse. His notes on the general history of the Mount are evidence of the careful and accurate observations made, and show a keen appreciation of the problems involved. Notwithstanding the great advance made in the knowledge of vulcanism since he wrote, no subsequent writings on Mount Gambier can properly summarize or replace the material of Chapter VIII. of his book (*Ref.* No. 2).

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(17) Browne and Valley Lakes.

(18) Leg of Mutton Lake.

H. Y. L. Brown (see *Ref.* No. 3) confines his remarks mainly to the depth, temperature, and origin of the waters of the lakes. In the section accompanying his report he marks only one "undoubted crater," that near the point where the Tower stands, and he writes:—"From the contour of the Blue and Valley Lakes . . . together with the appearances in their neighbourhoods, I think that they are not craters, but merely depressions caused by subsidence of the crust, consequent on the removal from below of such vast quantities of material as it is evident that has been erupted."

Professor Howchin (see *Ref.* No. 4) supports the views of the previous writer on this point, adding:—"The quaquaversal dip points to one centre of ejectment, while the depressed areas of the Blue Lake, the Leg of Mutton Lake, and the Valley Lake are undoubtedly sunken areas, the subsidence taking place late in the period of activity, or even after the volcano ceased to eject material."

(b) Contour Map.—The writer has made repeated efforts to confirm this conclusion of Professor Howchin, but his accumulated observations of both dip and contour strongly support the conclusion of Woods that there was a very important crater situated somewhere near the centre of the collapsed area that now contains the Blue Lake. The evidence for an undoubted crater near the foot of Tower Point (Mount Gambier proper) is equally clear.

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(19) Blue Lake.

In order to properly discuss the matter it was found essential to have a contour map of the whole Mount. This has therefore been prepared (see fig. 6). The hachured plan of the Mount and lakes (10 ch. = 1 in.), prepared by H.

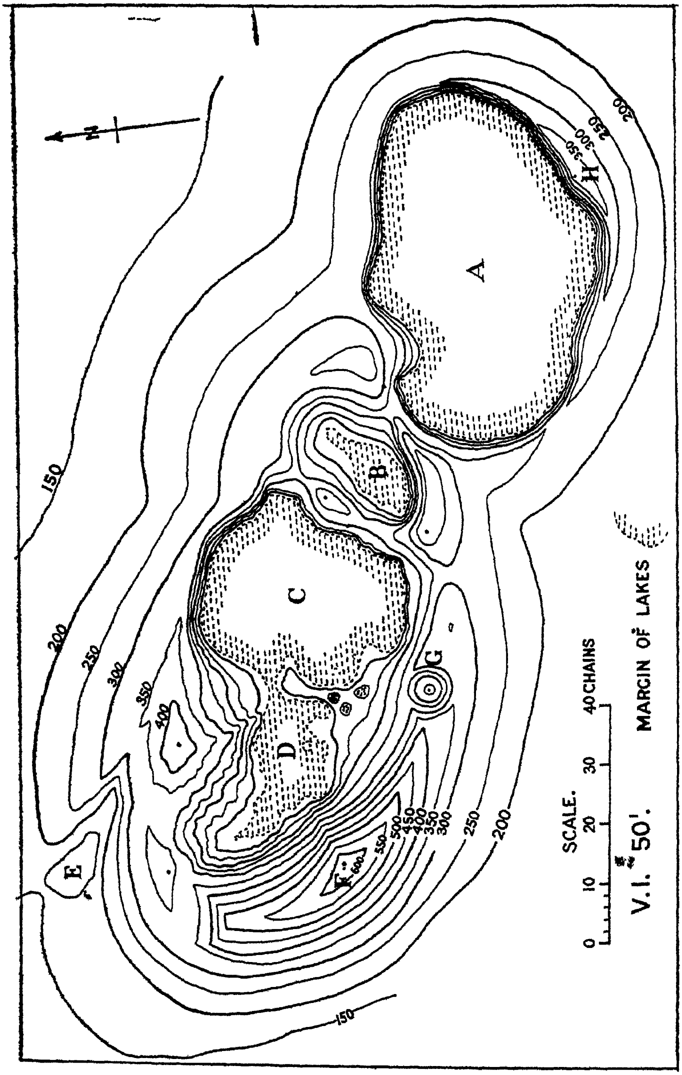

Fig. 6. Contour map of Mount Gambier, showing: A, Blue Lake; B, Leg of Mutton Lake; C, Valley Lake; D, Browne or Crater Lake; E, the Moorak depression; F, the "Tower Point"; G, the Punch-bowl; H, the Blue Lake Look-out.

Jacob, of the South Australian Lands Department, in 1910, was made the basis of the contour map. Numerous traverses were made around and across the area, wherever possible, taking two sets of aneroid observations by separate observers, and checking results at all intersections. The contour lines are plotted at 50-ft. intervals.

It is not claimed that this is a correct contour map of the locality, but in all essential features it is sufficiently correct for the purposes for which it was prepared. It has been found of great value in working out the reconstruction of the cones prior to subsidence.

(c) Reconstruction of the Cinder Cones.—In attempting this reconstruction, two lines of supporting evidence are available: (i.) the dip of the tuff beds where undisturbed; (ii.) the external contours where unbroken by the collapse.

It is therefore necessary to eliminate the areas disturbed by the subsidences. As already stated, these subsidences or collapses have led to the disappearance of almost the whole of the volcanic cones; they are arranged in the same linear direction as that of the Mount itself, and are shown in fig. 7, where the areas of most abrupt and definite collapse are darkly shaded and the surrounding areas affected by subsequent slumping and land slipping are lightly shaded. The portions unaffected (unshaded) are therefore those where we must obtain our evidence of dip and contour.

(i.) Dip of Tuff Beds.—Excellent exposures of dip are available at the following places:—The great faces on each side of the "buttress" that runs from the Tower to the margin of Crater Lake; the summit of the Sugarloaf (an isolated point north-west of the Tower); the northern and eastern faces of Valley Lake; practically the whole of the abrupt cliff face, averaging 250 ft. in height, that surrounds the Blue Lake; and a small section at the rear of the ornamental tower opposite Gordon's Monument.

The evidence of the dips in the western portion of the area is distinctly in favour of a centre of eruption somewhere about the centre of Crater Lake. In the eastern portion, around the cliffs of the Blue Lake, the dip is everywhere outwards from the centre of the lake, pointing to a centre of eruption there.

The evidence of dip about the central area is somewhat non-committal. Unfortunately there is no evidence of dip in the interior of the Leg of Mutton Lake, and the dips visible on the surfaces in the neighbourhood of this lake may be due either to the action of surface wash, or to light ash deposits subsequent to the formation of the present slopes. The section opposite Gordon's Monument is believed by

Professor Howchin to be due to subsidence, and this may be the case. If a true dip, it would indicate a higher cone at Blue Lake than is shown in figs. 7 and 8.

Summing up the evidence given by dip, we have a western crater (Crater Lake) and an eastern crater (Blue Lake), with a doubtful central area where an additional crater or craters may or may not have existed.

(ii.) Slopes of External Faces.—As will be seen from fig. 6, the whole of the lower outer slopes of the cones remains intact, with the exception of the depression in the north-west, and a small subsidence on the slope below the Hospital (not shown on the map). Before using the evidence of the exterior slopes to assist in reconstructing the cones it is necessary to establish two things:—1. That cones of volcanic ejectamenta are characteristically symmetrical about the centre of eruption. 2. That at Mount Gambier the present external slopes, where undisturbed, are practically coincident with the dip of the beds.

With regard to the symmetry of cinder cones, it is scarcely necessary to point out that this feature is one of the most consistent of all land forms. The neighbouring cone of Mount Schank, and the various cinder cones of related age in Victoria, are notably symmetrical. Most of the material of the Mount Gambier cones was of such a size as to be little affected by the prevalent winds, and the effect of the wind on the finer material would be no more than to somewhat flatten the eastern and south-eastern slopes, this feature is to be noted in the contour map (fig. 6). There is, therefore, every reason to assume that the cinder cones at Mount Gambier were symmetrical.

The coincidence of the slopes of the surface with the underlying stratification of the ash-beds is noticeable in all the cuttings seen. In places around the Mount, where the surface soil has been partly removed, the surface slope is found to be the same as that of the consolidated tuffs. Other observations support this idea, and it may be fairly claimed that the contour lines, where drawn in firmly in fig. 7, represent the general outline of the cones as originally built up.

The reconstruction shown in fig. 7 is based on the principles outlined in the preceding paragraphs, and on a mass of minor observations that it is not necessary to detail. The dips and contour lines preserved at the western crater (particularly Tower Point), and the eastern crater (particularly the Blue Lake Look-out), enable us to reconstruct these two cones, and the lines suggest them to have been 750 ft. and 550 ft. high respectively. The Blue Lake cone may have been higher.

We then find that there are two high ridges, partly surrounding the Leg of Mutton Lake, and composed wholly of

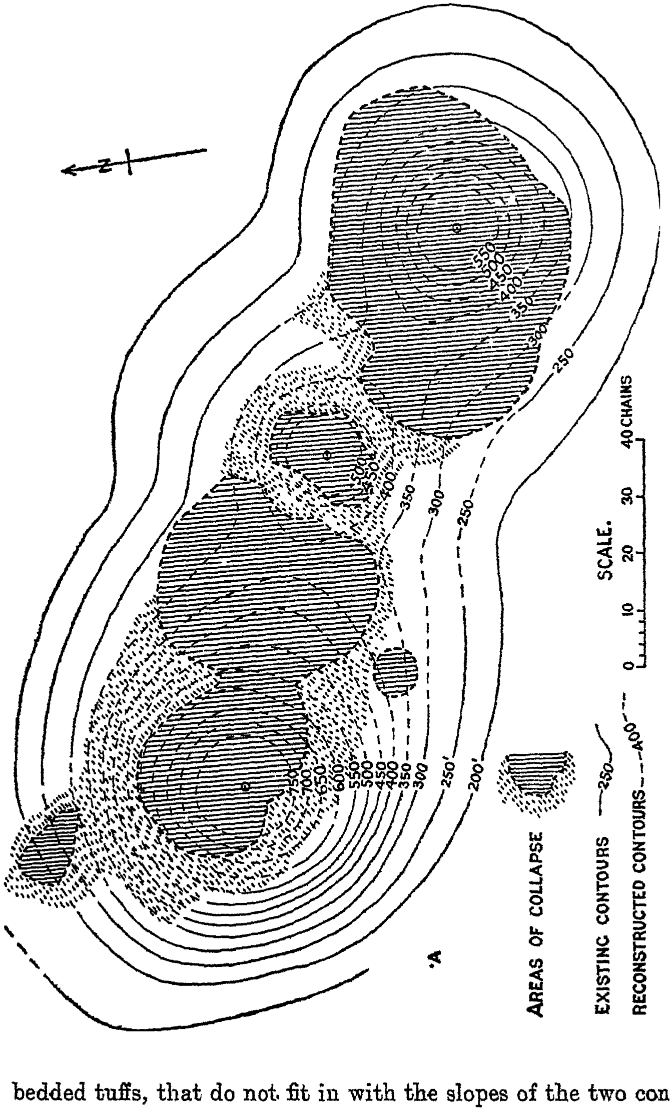

Fig. Pl ount Gambier, showing the eas affected by subsidei
truction of the cinder cone is originally built up.

bedded tuffs, that do not fit in with the slopes of the two cones reconstructed. Nor can these ridges be conceived as built wholly from either or both of these craters. In addition there is a re-entrant curve in the contours to the east of the point where the Bay Road approaches Blue Lake. There is also a less well-marked re-entrant curve in the same contours to the west of the Hospital.

Beyond the data of elevations and curve of contour lines, there is no evidence as to the locus of the third crater that must have existed hereabouts. On plotting the information available, one is reluctantly compelled to relinquish the attractive theory that the Valley Lake was the site of a crater, and to assume that a third and smaller crater existed in the small and deep depression now known as the Leg of Mutton Lake.

(d) Section through the Reconstructed Cones, showing Collapses, etc.—To test the truth or otherwise of the reconstruction, numerous true sections were drawn, and checked against the known facts of slope, dip, etc. The most informative of these sections is shown in fig. 8.

In this section (fig. 8), the known facts of structure detailed in previous paragraphs are embodied. The section is drawn from the point A, fig. 7, through the Tower Point to the centre of the "Mount Gambier crater," thence to the centre of the "Leg of Mutton crater," thence to the centre of the "Blue Lake crater," and thence through the highest point on the rim of the Blue Lake (the Look-out).

It would appear from the section that the ash deposits on the flanks of the Leg of Mutton (central) Lake might have been deposited from the eastern and western craters, but the section does not show the high

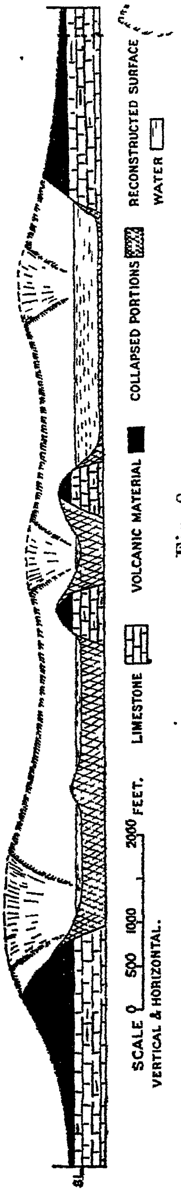

Fig. 8.

Section (vertical and horizontal scales equal) drawn through the reconstructed cones, and showing also the true shape of the present volcanic remnants, the underlying limestones, the collapses, and the lakes. The depths of the lakes are taken from the section published by Brown. (*Ref.* No. 3.)

ridges north and south of the Leg of Mutton Lake, and the other evidences detailed above, which can only be accounted for by the third (central) crater shown in the reconstruction.

Woods gives much detail regarding the order of eruption, but the writer could not discover any definite evidence on the matter. There was a brief explosive phase prior to the basalt flow, and that probably came from the western crater, as did the lava. Possibly the order of activity was:—1, an explosive outburst from the Mount Gambier crater; 2, a brief effusive phase at the same focus; 3, renewed explosive activity at that crater; 4, explosive eruption of Blue Lake crater; 5, explosive activity at Leg of Mutton crater. Still, there is no positive evidence against the idea that phases 3, 4, and 5 were contemporaneous.

9. THE SUBSIDENCES.

(a) Extent, Cause, and Time of Collapse.—As pointed out in the introduction to these notes, only remnants of the original cones now exist to mark the centres of volcanic activity at Mount Gambier. The actual extent of the subsidences is clearly shown in fig. 1 (general view), fig. 7 (plan), and fig. 8 (section).

It is difficult to imagine the reason for such extensive collapses. Woods suggests the draining away to the southward of a great mass of lava that had formed an underground reservoir, at comparatively shallow depths. He quotes evidence in favour of this (p. 250), which I have not had the opportunity of investigating.

To take the case of the Blue Lake subsidence, a huge block of rock, 170 acres in extent, and comprising about 300-ft. thickness of level-bedded limestones, 20 to 50 ft. of dense basalt, and possibly an average thickness of 350 ft. of tuffs, has disappeared abruptly and precipitately downwards into the earth.

The surrounding limestone country contains many caverns and sink holes, such as those known as Umpherston's "Caves," but none of these are at all comparable in size to those of the lakes. This suggests a genetic relationship between the underground spaces into which the collapse took place and the volcanic activity itself. Both, in turn, may be related to the line of crustal weakness which is suggested by the linear arrangement both of the craters and of the subsidences.

In other areas similar great crater depressions have been formed by a violent final explosion, blowing away the whole "roof" of the volcano. If that had been the case at Mount

Gambier, one would expect to find evidence of same in an arrangement of abundant scattered blocks of limestone, basalt, and bedded tuffs around the depressions. Huge blocks of basalt and limestone certainly occur, but these are occasional only, and are situated in all cases in the proximity of one or other of the three ancient craters The idea of accounting for the depression by explosion has not been previously put forward, and is here mentioned only in order to be dismissed for lack of evidence.

Woods believed that the subsidence was in part contemporaneous with the volcanic activity, but no evidence could be found for this, and the writer, on general appearances, prefers to agree with Professor Howchin that the subsidence may have occurred "even after the volcano ceased to eject material." It is, of course, possible that the collapses were not in all cases abrupt and precipitate, but may have occurred rather as a series of collapses, concentric to the margins of the vents.

(b) The Blue Lake.—This is the most remarkable and most fascinating of the subsided areas. Notwithstanding the fact that much of the native vegetation that clothed its precipitous sides has now disappeared (possibly since the advent of the rabbit), its beauty still deserves the enthusiastic admiration given by its discoverer and by early investigators. This is particularly so on a bright day, when the beautiful blue colour of the water is most marked.

The first person to venture on the lake was Governor Sir R. G. McDonnell *(Ref.* No. 2, p. 247). When one ventures in a boat on the lake for the first time, the unusual crystal clearness and coldness of the water, the known great depth, and a memory of its mode of origin, combined with the forbidding rampart of cliffs that everywhere surrounds the lake, quite justify the epithets of "weird," "uncanny," and "awe-inspiring" to the imaginative mind

The average depth of the water is 250 to 280 ft ; the height of the cliffs averages 250 ft. above the water. The shape is an irregular oval, and the area is about 170 acres The water supply of Mount Gambier town is derived from a well sunk alongside the margin of this lake, and is limited only by the capacity of the pumping plant. The high ridge north-east of the Leg of Mutton Lake is utilized as a storage reservoir, to provide the necessary "head."

If one followed the general terminology of physiographic text-books, the Blue Lake would be termed a "caldera." The typical caldera given by Professor W. M. Davis, in his "Physical Geography" (pp. 212, 216), is quite similar to the

Blue Lake depression. R. A. Daly (20) has subsequently discussed the term "caldera," shown to what varied uses it has been put by different writers, and prefers to apply the word to explosion forms only. His term "volcanic sink" hardly fits the case of Blue Lake, and it is probably best to refer to it in simple English as a "collapsed crater."

(c) The Leg of Mutton Lake.—This is a small, steep-walled depression. The sides are covered with soil and clothed with native and introduced trees, in striking contrast to the bare rock walls of the Blue Lake. One of the nurseries of the State Forestry Department nestles picturesquely at the bottom, alongside the lake. Brown's section suggests that the depth of this lake is about 70 ft., but it looks much shallower than that. Woods called this the Centre Lake; it has since received the present name from its shape. The depression is deep enough to show both the limestone and the basaltic layers, but they are apparently quite covered over with volcanic material that has slumped down or been washed down from above (see fig. B, pl. x.).

(d) Valley Lake.—This name was applied by Woods to both the present lake and the Crater Lake, which are connected by a shallow channel when the water is high, and disconnected when the water is low. The Valley Lake, as may be seen in fig. 6, is steep-walled, with good sections, on the east and north. The extent and nature of the collapse is comparable with that of the Blue Lake, and the water has the appearance of great depth. There is no definite record of the systematic sounding of any of the lakes except Blue Lake. The western wall is almost non-existent, and the southern wall is low and gently sloping. Down this southern wall a road has been constructed for tourist purposes.

On the peninsula, separating Crater Lake from Valley Lake, there are two or three funnel-shaped depressions, possibly due to small local subsidences, Woods regarded them as small craters.

The two irregular peninsula shapes that jut into this depression, partly separating the Crater and Valley Lakes, are probably due to the much greater amount of tuff that was here concerned in the subsidence (see fig. 7).

(e) Crater Lake (also called Browne Lake).—Excepting the Leg of Mutton Lake, this is the smallest, and apparently the shallowest, of the group. Mr. E. F. Crouch, of the Old Residents' Association, Mount Gambier, informs me that when his parents came to Mount Gambier, in 1841, this lake

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(20) Igneous Rocks and their Origin, R. A. Daly. New York, 1914 (pp. 144-6).

was empty. If so, the lake must be very shallow, and the year referred to must have followed a succession of droughts in the main intake areas of the sub-artesian basin.

The subsidence here has been very great, but subsequent land-slipping has partly obliterated the abruptness of the slopes, except on the south, where the great buttress of Tower Point rises, now the highest point of the Mount. On this southern wall there is an excellent exposure of the stratified tuffs overlying the limestone, and along the western wall, low in the depression, there is an exposure of ropy lava previously described. The lumpy, land-slipped slopes, on the north and west, are now clothed with dense bracken fern.

North-west of Crater Lake, a single peak called the Sugarloaf, stands high above the rest of the wall. It is interesting from the regularity of its structure, in the shaping of which erosion has played but a small part To the west, it slopes steeply down to the Moorak depression, and to the east its face is formed by the collapse of the crater area. On the other two sides, crescent-shaped depressions of the crater wall have occurred, leaving the Sugarloaf standing like a four-sided pyramid (see fig. 1).

(f) The Moorak Depression.—The most western of the subsided areas is small, but interesting It is flat-bottomed and not deep enough to contain water. It is noted in maps, but has not been remarked by previous investigators. On the north it is bounded by a long gently-sloping ridge, and as one approaches the depression over this ridge, coming from the town, the impression of its being the remnant of a concentric outer wall of an older crater is quite distinct. Other evidence does not support this idea, but this curious depression well merits closer investigation.

The ridge which bounds this depression on the north-west is partly cut through, giving an excellent exposure of the ash-beds; these beds closely follow the contour of the ridge, and suggest that the subsidence existed prior to the conclusion of the explosive activity. There is an old well in the flat-bottomed depression, but this is now partly filled in. Possibly this is the well referred to by the late Professor Tate in his class lectures as having been sunk 40 ft. through stratified ash.

The Moorak Station homestead stands on the bank of this depression, which is therefore here referred to as the "Moorak depression." It has been utilized as a rifle range, for which purpose it is eminently suited, being sufficiently extensive, quite level-floored, safe, secluded, and picturesque.

(g) The Punch-bowl.—This symmetrical, funnel-shaped depression is in the southern wall of the Mount, south of

Valley Lake (see fig. 6). Woods regarded it as an adventitious crater, but from his description it is clear that the walls were not then as exposed and bare as they are now. The dip of the stratified beds clearly continued uninterruptedly across the area now occupied by the depression.

The shape and size of this depression have been compared to those of the greater explosion craters made on the western front during the war. Possibly the Punch-bowl was formed by an isolated explosion late in the period of activity, without any subsequent ejection of material. It seems more likely, however, that it is due purely to a small subsidence occurring a little apart from the main line of collapse (see fig. B, pl x.).

(h) The Water of the Lakes.—As already mentioned, the water of the lakes is portion of that stored in the great sub-artesian tertiary basin of the ancient Murray Gulf, and the surface of the lakes slowly rises and falls, apparently in harmony with the rise and fall of the general water-table of the whole area. In some cases the rapid rise of the water has caused some anxiety locally. For instance, from the middle of the year 1909 the water continued to rise steadily for two years, and in December, 1910, stood 9 ft. higher than in June, 1909. Such increases in level can scarcely be appreciated in the general appearance of the deep and steep-walled lakes, such as the Blue Lake and the eastern portion of Valley Lake; but in the shallower portions of the Leg of Mutton and Crater Lakes this variation in level causes considerable alteration in their shape and appearance.

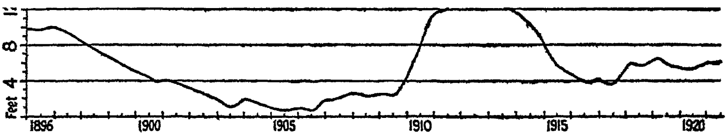

Fig. 9.

Graph showing the variations in level of the surface of the Blue Lake for the years 1896-1921, as recorded in the office of the State Hydraulic Engineer, and supplied by the courtesy of that officer.

During the past 25 years the limits in the variation of water level have been only about 14 ft. Further back in time, this variation may have been much greater. It has been mentioned that there is a local record that about 1841 and subsequent years the Crater Lake was dry. Writing in 1862, Woods says of the Leg of Mutton Lake that "the water at the bottom has only made its appearance, as I am told, within the last few years." These two lakes are to all appearances much shallower than the other lakes.

The graph shown in fig. 9 has been carefully compared with the corresponding rainfall records of the south-eastern counties of South Australia. This rainfall is approximately the same as that of the chief intake beds of the basin There is no close correspondence to be noted at first sight between the average annual rainfall and the variation of water level, but general relations are revealed by careful examination. The two wet years of 1909-1910 were, for instance, followed by a corresponding considerable rise in water level. The consistently low water level of the years 1902-1910 corresponds with the three dry years of 1902, 1904, and 1907. The great drought of 1914 was closely followed by a distinct and rapid lowering of the lake levels. The attempt to correlate the rainfall and variation of lake levels is, however, far from satisfying.

Apart from these major movements, as revealed in the graph, the detailed weekly records of water level show a minor annual movement that is of much interest. This consists in a general rise of level in the summer (December-January) months of the year, and a general lowering of level in the winter (June-July) months. This is obviously not due either to extra local consumption of water nor to increased evaporation,(21) since the rise in level corresponds with the increase of both these factors. The area is one of winter rains, and the obvious conclusion is that the summer rise is due to the arrival along underground courses of a previous winter increment of rain received in the main intake beds. Whether it is the previous winter's rains (six months before), or those of a season prior to that, cannot be discovered without more detailed figures and further investigation. It seems clear, however, that the rise or fall of the lake levels depends on the amount of rainfall either six or eighteen months prior to such rise, and argues either of those periods as the time taken for the water to travel underground from the main intake areas to Mount Gambier.

Further Note on the Correlation of the Rainfall with the Variation in Level of the Lakes.—Since writing the foregoing note, regarding the relationship between the rainfall of the south-eastern counties of South Australia and the variation in level of the Mount Gambier lakes, the rainfall records of the County of Lowan (Vict.) have been obtained by the courtesy of the Commonwealth Meteorologist (Mr. H. A. Hunt), and further efforts have been made to discover the exact relationship that exists between the rainfall and the variation in the lake levels. The rainfall records of County Lowan (Vict.) are specially considered, because that area has been shown (by A. S. Kenyon, *loc. cit.)* to be the main gathering ground for the underground supplies of this portion of the Murray Gulf sub-artesian basin.

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(21) The average evaporation per annum at Mount Gambier is 35 inches *(vide* Special Report on Lakes Leake and Edward, Ann. Rep. Govt. Geologist, S. Austr., for 1917, p. 14).

It has been pointed out by the Government Geologist (Mr. L. Keith Ward), in his Annual Report for 1915, that the underground water in south-eastern South Australia, although generally accepted as forming portion of the "Murray Gulf sub-artesian basin," is really of a dual character:—

(a) Sub-artesian water which is under greater pressure than that of the atmosphere, and which has travelled for some distance through the porous beds in which it is contained.

(b) Ground water derived from the downward percolation of the rainfall, occupying the pores, joints, etc., in the limestones, and being under atmospheric pressure only.

Observations made by the writer confirm the belief that the water underlying the Mount Gambier region mainly partakes of the nature of ground water, but is influenced by the annual increment of water received under pressure from the regions to the north and north-east.

For the purpose of discovering, if possible, the relationship between the rainfall and the variation in lake levels, consideration must be given to the following figures, which cover the last 26 years:—

A. The annual December levels of the Blue Lake, measured from a datum line selected by the Hydraulic Engineer's Department.

B. The annual rainfall of the south-eastern counties of South Australia, as published in the Statistical Register of that State.

C. The rainfall of County Lowan, in Victoria, as supplied by the Commonwealth Meteorologist.

		A.		B.	C.
		Ft.	In.	In.	In.
1895	....	25	10	22·03	17·47
1896	...	25	11	18·74	15·27
1897	...	24	5½	17·55	13·85
1898	...	22	7½	21·29	18·03
1899	...	21	1¼	19·82	16·27

		A.		B.	C.
		Ft.	In.	In.	In.
1900	...	19	11½	21·95	18·67
1901	...	19	2½	19·19	16·15
1902	...	17	11½	16·47	12·65
1903	...	17	7½	22·98	21·21
1904	...	17	1	18·09	17·50
1905	...	16	10½	20·90	20·31
1906	...	17	10	23·66	26·03
1907	...	18	7	18·34	18·70
1908	...	18	6	19·28	18·31
1909	...	20	3½	25·77	22·67
1910	...	27	3	25·08	24·31
1911	...	29	4	19·31	18·68
1912	...	28	8	18·50	19·82
1913	...	27	8	17·00	17·48
1914	...	24	1	11·48	9·76
1915	...	20	8	19·42	19·53
1916	...	20	1	24·14	23·08
1917	...	21	1	25·56	22·77
1918	...	22	1	16·87	16·66
1919	...	21	5	15·87	14·71
1920	...	21	10	19·91	21·03

The figures given in the foregoing lists have been graphed as shown in fig. 10.

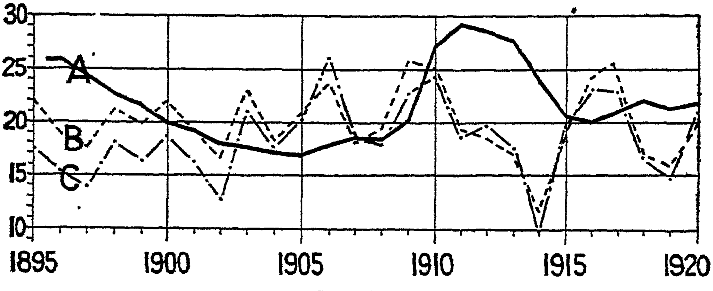

Fig. 10.

Graph showing: A, the variations in level of the Blue Lake (in feet); B, the annual rainfall of the south-eastern counties of South Australia (in inches); C, the annual rainfall of County Lowan, Victoria (in inches). From 1895 to 1920, inclusive.

It will be seen that there is no regular relationship, whatever, between the curve of the annual rainfall (which supplies both the ground water and the sub-artesian water of this area), and the curve of the annual variations in lake level. There is, however, a close relationship between the rainfall curve of County Lowan (Vict.) and that of the south-eastern counties of South Australia, the latter being throughout somewhat higher than the former (see fig. 10).

The apparent lack of correlation between the rainfall and the lake levels, as shown in the foregoing graph, was very disappointing, since the general evidence of the close relationship of these two factors is most clear. Attempts were therefore made to devise a satisfactory way of recording the rainfall so that its relation to the curve of the variation of the lake levels might be graphically demonstrated. It was realized that the most important point to be considered was the fact that the influence of the rainfall on the great reservoir of underground water in the South-East is a cumulative one.

An examination of the figures shows that when the rainfall affecting this area is from about 18 to 20 in. per annum, the level of water in the lakes remains practically stationary. From this it may be deduced that the amount of water that is added to the underground supply, from an annual rainfall of 18 to 20 in., is just about equal to the loss of water from this great underground reservoir per annum. This loss is due to some small extent to evaporation, to a very minor extent to wells and pumps, and to a considerable extent to the outlets along the southern coastline, where it constantly gushes forth in great quantities as, for instance, at the Beachport Springs, Dingley Dell Creek, Ewen Ponds, the Piccaninnie Blue Lake, etc.

If we regard the underground reservoir of the south-eastern district as a closed system, with an annual outflow of a quantity which we may call "x," and if we further accept "x" as the average annual increment of water received by this basin from an annual rainfall of 18 to 20 in., then we are in a position to construct a new graph, taking into account the cumulative effect of either a series of years wetter than the average (which is 18 to 20 in. per annum), or a series of years drier than the average.

Graphs of this nature are shown in fig. 11, and were constructed as follows:—Selecting an arbitrary point to represent the position for the year 1895 (curve B, fig. 11), the amount by which the 1896 Lowan rainfall is less than 19 in. is plotted below the level selected for 1895. Similarly the amount by which the 1897 rainfall is less than 19 in. is plotted as a further downward movement below the level shown for 1896, and so on, so that for each year the difference between the actual rainfall and 19 in. is plotted cumulatively. In fig. 11, the bottom line A represents the actual curve of the variation in the water level at Blue Lake. The line B represents the curve drawn by the above method, showing the cumulative effects of variation from the rainfall of 19 in , considering the County of Lowan (Vict.) only. The line C, which has been arbitrarily placed above that of A and B, represents a similar curve to that of B, and is based on the rainfall of the south-eastern counties of South Australia, but with 20½ in. as the basis of calculation instead of 19 in.

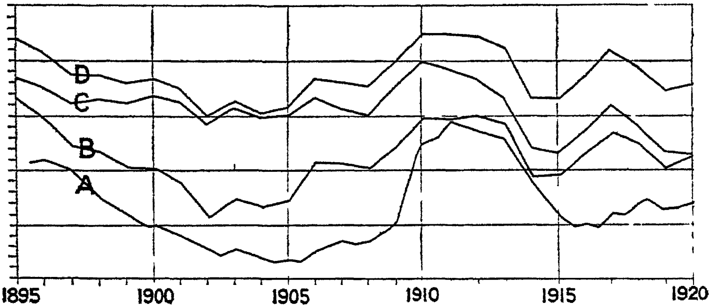

Fig. 11.

Graphs showing the relationship between the variation curve of the lake levels and the curve of the cumulative effects of the annual rainfall above or below certain selected bases. The vertical units represent 2 inches for curves B, C, and D, and 1 foot for curve A.

It will be noted that the nature of the curves coincides in a remarkable way and demonstrates the correctness of the assumptions upon which the curves are based. Various other curves have been drawn taking other annual rainfalls as providing the equivalent to "x," and these curves are, in all cases, similar to those shown in fig. 11, but bearing a less close coincidence with the curve A than the ones selected.

Mention has been previously made of the fact that the lake levels, on the whole, show a distinct rise in December as compared with June. Since this is an area of winter rains it seems clear that a proportion, at any rate, of the water of the Mount Gambier district comes from a distance, and takes about six months to make its influence felt. Further consideration of the curves in fig. 11 show that in some cases the whole effect of a high or low rainfall is not shown even within six months, but may continue to make itself felt for a year or so afterwards.

It is interesting to note that with variations from an annual rainfall measured in inches, of which only a portion soaks into the ground, we have consequent variations in the level of the underground water amounting almost to an equivalent number of feet. This is, of course, due to the fact that the ground water is only filling crevices, pore spaces, and occasional rifts and caverns in the limestone rocks. In some cases, as in the dry year of 1902, or the wet year of 1906, the effect on the level of the lakes was not proportionate to the rainfall. It is suggested that this is due to the variation in the amount of water that percolated into the ground, dependent on the distribution of such rainfall throughout the years mentioned. In 1902, for instance, the proportion of water that soaked into the ground may have been relatively greater than that of the wetter year of 1906.

In drawing the various curves it was found that those based on the rainfall of County Lowan bear the closest resemblance to that of the variation in the Mount Gambier lake levels. It seems fair to accept this as corroborative evidence of the opinion that a considerable portion of the underground water comes from the Lowan area. There must, however, be a fair percentage of percolation into these limestone beds from the general rainfall of the Mount Gambier district, so that the variation in lake levels is dependent on both factors. The curve D (fig. 11) is drawn to express this, being based on the mean of the two sets of annual rainfall figures given above.

From the evidence given in these graphs one would be fairly safe in prophesying the movement of the water level in the lakes, year by year. According as the year's rainfall, up to say October or November, varies from the average of 18 to 20 in., there would be an appreciable rise or fall in the December level, from that of the previous December. by an amount that could be calculated (approximately) from the graphs given in fig. 11.

10. SCENIC AND ECONOMIC ASPECTS.

Though the geological features of the Mount Gambier volcanoes are on so small a scale, they have had a very great influence from the economic point of view.

The fertile soils of the ash deposits, together with the visible unlimited water supply of the lakes, led to early settlement in the district, and to the rise there of a well-built and prosperous town, that has become the chief centre of the south-eastern districts of South Australia.

The history of the volcanic area having been so unusual and varied, as herein imperfectly described, the resulting scenery is equally notable for its variety, beauty, and unexpectedness. For this reason the town has become noted as a tourist resort. Practically the whole area of the Mount itself is reserved for public purposes—Botanic, Forest, or Public Park—and much has been done to add to the beauty by planting and improvement, without destruction of the unique natural features.

The well-built nature of the town is largely due to the abundant supplies of good building stones (limestones and dolomites). The basalt is used for road making (22) and the ash forms excellent footpaths. The water supply is drawn from the Blue Lake. But for the existence of the volcano, the area would doubtless consist to-day of a broad limestone plain, sparsely settled, and economically unimportant.

11. SUMMARY.

1. The chief features of the previous literature of the Mount Gambier area have been noted, and the main items of its history described.

2. The distribution of the volcanic ash has been mapped and a contour plan of the Mount prepared.

3 General conclusions regarding the course of the later geological happenings have been arrived at, after a full discussion of the available evidence, as follows:—

4. Towards the end of the Newer Basalt period, at a time little antedating the arrival of man, volcanic outbursts occurred, subaerially, on the limestone plains of south-eastern South Australia, associated with the very extensive outbursts of Western and Central Victoria.

5. A minor explosive phase was followed by the extrusion of a small lava flow. The main crater continued its explosive activity and two other craters opened through the lava flow along a line of crustal weakness. These eruptions continued for perhaps two or three months, and then ceased, having built up three cones to an average height of 650 ft., and covered 25 square miles with ash deposits.

6. Subsequently extensive collapse took place along the line of volcanic activity, and practically the whole of the three cinder cones caved in, forming great depressions, in the deepest of which the waters of the sub-artesian basin formed lakes.

7. The origin of the water of the lakes is discussed, and also the variation in the surface level, and suggestions are put forward regarding the rate of movement of the waters in this important sub-artesian basin The close correlation between the annual rainfall and the variation in level of the underground water supply has been graphically demonstrated.

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(22) This is brought from Mount Schank; the basalt at Mount Gambier is quite inaccessible.

8. The special features of the up-building and subsidence of the Mount have been discussed in detail, and, finally, the economic value of each important feature has been described.

DESCRIPTION OF PLATE X.

Fig. A. Portion of the Blue Lake, looking eastward. The cliff on the far side shows clearly the level-bedded marine limestones (1), and the stratified volcanic material (2), while portion of the basalt flow separating these two series has been emphasized by a broken line to show it more clearly. A thicker development of the basalt may be seen on the left, just beyond the pumping station.

Fig. B. View of portion of Mount Gambier, showing the Leg of Mutton Lake in the foreground, Tower Point beyond on the right, with the Punch-bowl in the upper left-hand portion of the picture. The tree-clothed ridge in the centre of the picture separates the Leg of Mutton Lake from the Valley Lake, but the latter is not visible; portion of Crater Lake may be seen at the foot of the buttress that runs down from the Centenary Tower.

(Photographs kindly lent by the Director, S.A. Tourist Bureau.)

ON THE OCCURRENCE OF ABORIGINAL STONE IMPLEMENTS OF UNUSUAL TYPES IN THE TABLELAND REGIONS OF CENTRAL AUSTRALIA.

By PROFESSOR WALTER HOWCHIN, F G.S.

[Read September 8, 1921.]

PLATES XI. TO XXI.

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I. INTRODUCTION.

In May, 1904, the writer spent a fortnight on the Stuart Creek Cattle Station, in the Lake Eyre district. Attention was given to the occurrence of worked stones, which are usually to be found in any part of South Australia on virgin soils and in sand-drifts. In the sandhill country of Central Australia, which is mostly lowland, these Aboriginal remains are of relatively small size and carry the appearance of freshness, as though only recently made. On higher ground, in the tableland country, and amongst the "gibbers," a different type of implements is met with. These latter are commonly of larger size than those found in the sandy country. are roughly chipped, and carry the same characteristic colouring which is common to the loose stones of the uplands. A fair number of this class of implements was obtained on the Stuart Creek "run," some of which were given to a scientific friend who was on his way to England, and the remainder was presented to the Adelaide Museum, where they are on view.

In July, 1921, the writer, while on an expedition into Central Australia, had a further opportunity of pursuing these investigations. Limitations as to time and rapidity of travelling prevented extended observations of this kind, so that the locality tested for the purpose was mainly that in the vicinity of the Macumba Head Station, situated about 34 miles to the northward of Oodnadatta.

Here, as at Stuart Creek, the gibber slopes of the tableland yielded examples of the large, roughly-chipped, and ferruginously-coated implements. Some of the smaller worked implements were found mixed with the larger, but whilst the former are found generally distributed over the country, irrespective of the nature of the ground, the heavier implements appear to be restricted to the gibber or upland regions.

The country south of the MacDonnell Ranges is strongly differentiated by two well-marked physiographical features The lowlands and wide river valleys are covered by rolling hills of sand, temporarily fixed by growing vegetation, or in a condition of drift At a higher level, not usually exceeding 100 ft. above the normal level, are flat-topped hills that go under the name of the "tableland." These flat-topped hills represent an ancient land surface, which, by differential denudation has been dissected, and the remnants of the same are left at a higher level than the intermediate ground. The larger fragments of the tableland have the features of a "mesa," from which extend spurs and buttes with abrupt sides and terminals. like gigantic tips from smelting works.

These peculiar and picturesque features can be explained from the fact that the older land surface, represented by the tableland, consists of a capping of hard rock, underlying which is a softer layer of rock, whitish in colour, and of an argillaceous kind. The hard capping of these flat-topped hills is sometimes a true sandstone, but, more commonly, the original fragmental material, whether of sand, fine gravel, or clay, has become consolidated by the infiltration of colloid silica. The silica has penetrated the interstices of the sandstone, converting the mass into a chalcedonized rock, which, in the case of the more finely-textured varieties, possesses, more or less, a conchoidal fracture and vitreous lustre. The origin of this extensive silicification of the surface rocks in the interior of Australia can be explained from the peculiar climatic conditions of the country (see Howchin's Geology of South Australia, p. 450). Similar effects are also produced in arid regions in other parts of the world.

The great heat of the summer months and the extremes of temperature which may occur in Central Australia at any time of the year,(1) cause this highly siliceous rock to split under the stress of rapid contraction. This effect is strongly marked along the exposed edges of the table-topped hills, developing a vertical face of fractured rock at the top of the cliff, which may be from 6 ft. to 12 ft. in thickness. The fragments split off from the parent rock, in this way, follow the gravitational slope and slowly make their way to the bottom of the scarp. The distance separating these residual portions of the tableland may amount to a mile, or many miles, but the broken fragments of the hard capping, that once overspread the country, are left behind in the intervening spaces. This is one of the most characteristic features of Central Australia. The hard vertical faces of the escarpments have received the name of the Desert Sandstone, and the scattered stones derived from its waste, and which cover thousands of square miles of territory, are the so-called "gibbers."

It is seldom that such large stones, possessing a fairly good conchoidal fracture, are available for making stone implements as is the case in the Desert Sandstone country. Not only is the sandstone chalcedonized but the argillaceous beds have, in some cases, been changed to a porcellanite, which has been much used by the natives in making the cutting-stone which is invariably attached to their womerah. Implements made from this class of stone are always of small size, while the chalcedonized sandstone lends itself to the manufacture of larger implements.

II. AUTHENTICITY OF THE STONE IMPLEMENTS.

The question may be raised as to whether the chipping, in the case of the implements now under description, has been caused by natural processes rather than by human workmanship. There are no circumstances in the case that would suggest a natural origin. None, for example, such as might have been derived from subsoil pressure and differential movements or creep, as observed by Mr. S. H. Warren, in a section of the Bullhead flint-bed [XXVIII.,(2) p. 238]. In the tableland country there has been, practically, neither local strain or transport. The Desert Sandstone capping is generally underlain by a soft argillaceous bed that easily yields to the weather.

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(1) During a recent expedition into Central Australia undertaken by Professor Sir Edgeworth David and myself, the diurnal temperature, in July, on one occasion had an extreme range of 50° F. in the course of twenty-four hours; the day temperature, in the shade, reached 86° F., and the minimum, at night, 5 ft. from the ground, was 36° F.

(2) Numerals in small caps. refer to the Bibliographical References at the end of the paper.

As the latter wastes the harder stones on top are gradually let down to a lower level Even in the case of the scarps, flanking the "table-tops," the slope is gradual and could give no gravitational impact that might cause a vibration equal to a cause of fracture. Again, the Desert Sandstone is coarser in the grain than the chalk-flints and does not so readily fracture by compression. In a field of gibbers one stone does not press against another, nor are they heaped together, but evenly strewn over the surface where they were left by the slow removal of the more friable bed on which they rested.

The shapes exhibited by these gibber stones have arisen from various causes. The process of silicification has often been partial in its operations, causing peculiarities of shape and differential weathering. Solar influences and rapid changes of temperature tend to the breaking up of the siliceous rocks. This may occur under two forms. On a larger scale the rocks are split, *in situ*, in a way that simulates jointing; and, in a minor way, circular depressions sometimes occur on a smooth face of rock, as though sun-flaked, and has probably been so caused. In the case of the stone implements collected from the gibber country, there are sufficient evidences of design in their workmanship to prevent any mistake being made between the sun-flaked and the man-flaked In the former case the features are those of circular or oval depressions that occur on the face of the stone, either oddly or without any definite order, while in the worked implements, even where a naturally-shaped stone is used, there is evidence of selection in the general shape of the stone and intention in the chipping. Except in the case of oval-shaped implements, there is a thick edge, or butt, at one end, which is unchipped, suiting the tool to the hand, while the lateral edges are trimmed in such a way as never occurs with sun-flaking. This is seen in the number of chippings (amounting to scores in some examples) that have a uniform size and lineal direction along the edge, and, at times, are supplemented by a few chippings on the under-side of the edge where it was needed to secure a straight cutting edge.

III. DESCRIPTION OF THE TABLELAND IMPLEMENTS.

(a) GENERAL FEATURES.

1. The implements that have been secured under the circumstances already explained, can be separated into two divisions:—(1) Those that have been struck off as a fragment from a larger mass, or core, and show conchoidal fracture with a bulb of percussion. Examples belonging to this division are, usually, smaller and better finished than those mentioned in the following section. (2) Implements that have been

developed from a "gibber" stone in its natural condition. These have evidently been selected on account of their size and shape being adaptable, after modification by chipping, for certain useful purposes. It is not always an easy matter to assign some particular form to its proper place in this classification, on account of the influence of solar heat in effecting fractures in fine-grained siliceous rocks. Sun-flaked rocks sometimes show a curved and smooth face on the plane of fracture,' which simulates conchoidal fracture, but is destitute of a percussion bulb. When a face of this kind occurs, it must be doubtful as to whether the flaking has been done by the workman, or whether the latter has availed himself of a fragment which had already been severed from the parent rock by solar action. The element of doubt, as to the origin of the fragment, has no bearing on the evidence of human workmanship in the subsequent treatment of the stone, which, in many cases, is beyond doubt.

2. Whether a conchoidal bulb be shown or not, there is, almost invariably, a flat face on the one side (which is the ventral or under-side), and a, more or less, raised surface on the other (which is the dorsal or upper-side). In certain prehistoric stone implements of Neolithic Age, as well as in the case of the stone implements of the existing tribes of Aborigines in Australia, this flat under-side forms a part of the manipulation and is conchoidal in character. In the tableland implements, it seems probable that some owe their flat under-sides to natural causes, either by jointing or some other form of natural fracture.

3. The chipping is, for the most part, developed on the convex or upper-side of the implement, and sometimes completely surrounds the specimen. If the curvature of the edge requires that, for the making of a straight cutting edge, the chipping should, in places, be developed on the flat, or under-side, it is chipped on that side also. This is not peculiar to the type now under description, but examples of this kind occur in the stone implements of all ages—it is an evidence of design.

4. The tableland examples are frequently of a size that is much in excess of the usual type of implements found in other parts of Australia.

5. Pointed implements are particularly common. The point is sometimes developed as a prominence between two concave scrapers and was no doubt intended for use, as well as the scrapers with which it is associated in the same implement. It is sometimes improved by a deep notch on one side, as in fig. 1, pl. xv., and pl xvi., and is sometimes claw-shaped, as in fig. 1, pl. xii. The association of "beaks"

and concave scrapers is the chief characteristic of the most ancient types of implements, whether eolithic, palaeolithic, pygmian, or Tasmanian. The same occurs in the case of the Australian artefacts, but these are usually of smaller make than the tableland examples

6. Hand choppers of large size also occur. Some of these have a heavy butt end and, at the other, are worked to a point, like the French form known as a *coup-de-poing*, but instead of being worked to be biconvex in transverse section, as in the case of the latter, they have a flat ventral face and are roughly worked on the dorsal side (see example described, No. 15, and figured, pl. xx.). In other examples the implement takes a reversed form, so that the pointed portion becomes the hand end, and the opposite, or broad end, is chipped to a cutting edge (pl. xix.).

7. The examples answering to the tableland type are, almost invariably, highly coloured of an ochreous or ferruginous hue, varying as reddish, yellowish-brown, or dark-brown, sometimes almost black, agreeing in all respects with the colour that is characteristic of the gibbers among which they are found. This colour is, indeed, characteristic of stony deserts in all parts of the world, and arises from the presence of iron in the soil and waters of a country existing under arid conditions.

8. All the implements of the gibber type carry more or less of a glazed surface. This glaze is frequently as fully developed on the chipped surfaces as it is on the unchipped portions. The same feature is commonly seen on genuine prehistoric stone implements in all countries, and is taken as an evidence of age and genuineness It is as evident to the touch, in an oily and greasy feel, as it is to the eye as a glaze. This feature, often associated with a weathered surface in flints, is known as *patina* from the resemblance that it bears to the glaze of pottery, or its likeness to an oxidized coating seen on metals as the result of weathering.

9 While the chipping is very clearly defined in the examples under description, some of them possess a blunted edge which can be best explained from the wear they have suffered by use.

(b) DESCRIPTION OF INDIVIDUAL EXAMPLES.

1. *A claw-shaped Instrument.* Size, 5¼ in. × 4¼ in. The under-side is roughly shaped to a flattish face by a number of secondary chippings that do not show conchoidal fracture. It is ridged on both faces and has a roughly-triangular outline. The trimming has been cleverly executed (on a not very workable stone) so as to produce two sharp edges and a curved

"beak" at the apex. The base is thick and unworked. It is deeply stained to a dark-brown colour The included sand-grains are glistening with a feebly developed glaze. *Loc.*, Stuart Creek (pl. xii., fig 1). [For claw-shaped examples from the Red Crag, see ix., figs. 35, 36.]

2. *An Implement with the shape of an irregular isosceles triangle.* Size, 4¾ in. × 3 in. Material, a fine-grained sandstone. Under-side exhibits conchoidal fracture in one large curve. Upper-side has been formed by striking off two conchoidal flakes, leaving a dorsal ridge which is non-symmetrical. Secondary chippings on two edges, directed to a point, the termination of which is broken off. Basal portion thick and unworked. Colour, dark brown; *patina*, strong. *Loc.*, Stuart Creek (pl. xviii.).

3. *A pointed (beaked) Implement with nearly parallel sides.* Size, 3¾ in. × 2½ in. A very fine-grained siliceous sandstone, brecciated. Under-side formed by a convex conchoidal fracture. Upper-side, chipped to an irregular cutting edge all around, terminating at apex in a distinct "beak." The ridge on the upper-side is sunken and cavernous through defective silicification. Colour, lightish-brown on under-side, darker on upper, and especially dark on the chipped edge. *Patina* well developed. *Loc.*, Stuart Creek (pl xiv , fig. 1).

4. *Lozenge-shaped Implement.* Size, 5 in. × 4 in. In composition, a typical example of Desert Sandstone, possessing a good conchoidal fracture. Under-side is formed in one smooth surface with large percussion bulb. Upper-side is ridged inequilaterally, and a less defined ridge is seen towards the right-hand edge. On the left a portion of the original surface of the stone is preserved. The base is short and thick. Except at the base, very fine secondary chippings occur around the edge. At the apex—opposed to the base—a very prominent point, or beak, is formed, by the creation of a notch on one side. Colour, faintly reddish, darkest on the natural surface. Glaze, slight. *Loc.*, Macumba (pl xvi).

5. *Roughly-triangular and pointed Implement of a distinctly rostro-carinate type.* Size, 3½ in. × 2 in. Stone, fine-grained (porcellanite). Thick. Under-side smooth, showing conchoidal fracture. Near the centre of the under-side is an oval depression, left by a flake that has been removed by solation. Upper-side is shaped by primary (coarse) and secondary (fine) chippings. Apex, pointed at termination of dorsal ridge. Basal end, thick. Reddish-brown in colour, lighter at the chipped edges. Glaze, moderate. *Loc.*, Stuart Creek (pl. xii., figs. 3 and *3a*). [Compare this implement with the following: ix., figs. 1-7; xi., pls. 23-27.]

6. *A roughly-made Implement, quadrate in outline, with a strong beak'' at one angle.* Size, 4 in. × 3 in. Under-side flat with vesicular-like depressions on what appears a natural plane of fracture. Upper-face flattish and irregularly flaked. Secondary chipping on two-thirds of the circumference, ending on one side in a strong protuberance or 'beak.'' Colour, a very dark brown—darkest on the worked edge. *Patina* well developed, more particularly so on the chipped edge. *Loc.*, Stuart Creek (not figured). [Compare ix., figs 27-30.]

7. *Naturally fractured Stone utilized for making Hollow Scrapers.* Size, 3½ in. × 3 in. Roughly quadrilateral in outline. Flat underneath; irregular on upper-surface. Hollow scraper ending in stumpy beak on left edge and a shallow double scraper on the right. Basal edge thick and unworked. Reddish stain; edges, where worked, are of a lighter colour. Glaze, slight. *Loc.*, Macumba (not figured).

8. *Cutting Tool and Hollow Scraper.* Size, 3 in. × 2½ in. A fine-grained siliceous rock (near porcellanite). Under-side curved and smooth but gives no evidence of 'bulb.'' The fragment has probably been flaked off a larger mass by sun-heat. Upper-surface irregularly chipped, showing ridges bifurcating from the basal edge. Secondary chippings follow the edge in an almost complete circle, and a strongly developed hollow scraper is formed on the right edge. Colour, reddish-brown, rather lighter on the edges. *Patina* well developed. *Loc.*, Stuart Creek. This implement gives evidence of much wear, in which the divisional lines between the respective chips are almost wiped out. It has the appearance of age, and may have been worn by drifting sand (pl. xii., fig. 2). Resembles a common eolithic type.

9. *Knife and Hollow Scraper.* Size, 3½ in. × 2⅓ in. Constructed from a fine-grained, siliceous sandstone. Under-side smooth by conchoidal fracture but without a clearly-defined bulb. Upper, or convex, side chipped to a fairly uniform outline. The right-hand edge is very finely chipped to a straight cutting edge, and the left-hand edge is similarly chipped, forming a concavo-convex, crescentic cutting edge. To the right of the point, or beak, a hollow scraper has been formed by a deep notch. Colour, slightly reddish. Glaze, dull. *Loc.*, Stuart Creek (pl. xv., fig. 1).

10. *Implement nearly circular in outline with prominent point, or beak.* Diameter, 2½ in. On the under-side there is a very distinct bulb of percussion with conchoidal curviture. The upper-side has been formed by seven well-defined and symmetrical flakings, each of which has been struck off by a single stroke. One of these occupies the crown, and this apical fracture forms the centre around which the six other flakes

were removed, and which were of about equal size. The entire circumference is very finely worked, but the chief feature is the very cleverly manipulated point which may have been used as a borer. It is of a uniform reddish colour, with a feeble glaze. *Loc.*, Macumba (pl. xiii., fig. 1). [Compare IX., fig. 43.]

11. *Ovately formed Scraper* Size, 3¾ in. × 2½ in. Underside approximately flat with doubtful percussion bulb. Upperside shows the natural surface of stone, in a marginal band half around the specimen, and the crown has been reduced by flaking. Secondary chipping has been done all along the edge, which is somewhat serrated, forming an oval tool that was probably used as a scraper. Colour, reddish-brown, somewhat lighter on the chipped edge. Glaze, somewhat feeble. *Loc.*, Stuart Creek (pl. xiv., fig. 2)

12. *Adze, with cutting edge two inches in width*, forming the widest part of the implement, which is three inches in length. The material is very fine in the grain and is of the porcellanite type. The under-side is fractured along two planes that are opposed to each other at an angle of about 10°. The implement is thickest at the basal extremity, gradually thinning towards the cutting edge. The upper-surface has been worked to produce this latter effect. The cutting edge is rather roughly chipped and gives evidence of wear by use. Colour, dark red. *Patina* well developed. *Loc.*, Stuart Creek (not figured).

13. *Hand Chopper.* A large flat subtriangular stone, measuring 6 in. × 5½ in. Appears to have been a thinnish and flattish gibber that had been fractured from the parent rock by natural causes. It is fine-grained and very siliceous. Upper and under-faces show no attempt having been made at trimming. It has been worked on one edge only, showing a cutting face 4½ in. in length, and gives evidence of much wear. Dark red on under-side, rather lighter on the upper; chipped edge almost free of colour, but is more glazed than the rest of the tool. It is a most uncouth and rude implement that was probably used as a hand-chopper, as the thick part of the implement is on the side opposed to the cutting edge and has been rounded off to suit the hand, while the opposite end has been worked to an obtuse point. *Loc.*, Macumba (pl. xvii.).

14. *A fine example of a Hand Chopper.* Size, 6½ in. × 4½ in. The stone is a typical example of Desert Sandstone and has been a "gibber," which was evidently selected on account of its suitable shape. The implement is roughly triangular, and both upper- and lower-surfaces are in their native form and are almost parallel to each other. The cutting edge has been developed in a curved outline on the

base of the triangle, while, at the opposite extremity, there is a strong knob-like finish which was improved upon by the workman chipping it to a shape most convenient for gripping by the hand. The main secondary chipping, to bring up a cutting edge, has been done on the upper-surface, but there has also been complementary chipping done on the lower-surface, and as the chips struck off, in this way, were unusually large, the cutting edge has a wavy outline with a span of about an inch in each curve. The natural face of the above is a bright red, the chipped edge is rather lighter in colour, especially so on the under-side. It was evidently intended to do heavy work in cutting or splitting. The glaze on the natural surfaces is greater than that seen on the worked portions. *Loc.*, Macumba (pl. xix.). Dr. Horne has figured an example almost identical with this implement [see v., fig. 31].

15. *Thick-backed, roughly-triangular, single-edged, and pointed Implement.* Size, 5¾ in. × 3¾ in. The stone is a typical example of Desert Sandstone. Under-side is flat, having been formed by striking off a single flake but without conchoidal curves. Upper-surface shaped by coarse flaking, with an inequilateral ridge and worked to a cutting edge on one side. The point is also trimmed. Butt end, thick, and formed by the natural surface of the stone. Colour, bright red on the under-side, but the flaked upper-surface and worked edge are almost free from ferruginous colouration. Glaze, very slight. *Loc.*, Macumba (pl. xx.).

16. *Chopper or "Tomahawk."* Size, 4 in. × 2¾ in. Constructed from a very fine-grained form of Desert Sandstone, and is very siliceous. The stone, for the most part of its surface, shows numerous weathered cavities (resembling vesicular structure), which is, no doubt, the result of imperfect diffusion of the cementing agent under the process of silicification. The implement is biconvex in transverse section, and without distinction as to sides. The butt end is at right-angles to the longitudinal section and is flat. The opposite end is worked to a smooth, biconvex, crescentic edge, which is continued on one side of the implement to the butt; and, on the other, is roughly worked, so as to give a uniform outline to the implement, but was not intended for cutting. The colour is a dark-reddish-brown, with strongly developed *patina*. *Loc.*, Stuart Creek (pl. xxi.). This is, perhaps, the most interesting specimen in the collection, and, from appearances, may be the oldest. It bears a striking resemblance, in general form, to the "tomahawks" used by the Aborigines of Australia at the time of European settlement, but whilst the latter were almost invariably made from

igneous dyke rocks,(3) the present specimen is made from a siliceous sandstone. The Aboriginal "tomahawk" was ground and polished at the edge, and, sometimes, up to the middle of the implement. The Stuart Creek specimen, now under description, was carefully chipped to a cutting edge, but the edge has been rendered so smooth that it seems probable that some amount of grinding of the edge has been done to improve its cutting qualities. It must be either that, or age and weathering have reduced the prominences which marked the outlines of the individual chips struck off in its manufacture. It is certainly a unique specimen of its kind.

IV. Origin of the Implements.

(a) POSSIBLE THEORIES.

As the stone implements which occur in the tableland country of Central Australia differ, in many respects, from those commonly found elsewhere in Australia, the question naturally arises as to their age and origin. That they have a very considerable antiquity is manifest from their condition by weathering, the presence of a natural glaze seen on most of the specimens as a consequence of age, and also from the ochreous "skin" by which they are commonly coated. There are several possible explanations as to their origin.

1. They may be only local variations of the artefacts produced by the existing native tribes of the country, but possessing a considerable prehistoric antiquity.
2. They may be the earlier and cruder attempts at the making of stone implements which the existing Aboriginal people passed through before attaining the greater skill shown in later stages of their history.
3. They may be the remains of an earlier race of people, as the Tasmanians, for example, which may have occupied the ground in the far past as the true Aboriginal race, but were displaced, or exterminated, on the mainland, by the present natives of Australia, who exhibit greater virility and a more aggressive spirit than the Tasmanians possessed.

Something can be said in favour of the first of these suggested possible origins of the tableland implements. Habit in the Aborigine is, to a large extent, regulated by surrounding conditions, as happens also with the more civilized races.

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(3) In the Adelaide Museum there are a number of implements labelled "wedges" that are hatchet-shaped, resembling, but of thicker make than the common "tomahawks." They are made from a greyish-coloured quartzite, are symmetrically shaped, ground to a smooth surface throughout, and the majority have a transverse groove for hafting. All these implements were received from the River Darling country, mostly from Albemarle. The specimen, now described (No. 16), is quite distinct from these.

We may judge that the size of his tool would largely depend on the size of the raw material available for its manufacture; and, also, on the facility with which it could be manipulated. Moreover, where a suitable stone for trimming occurs in unlimited quantities and distributed over wide areas, the Aboriginal craftsman may have been prodigal of his workmanship, and his decision as to whether he should keep the freshly made implement for future use, or leave it behind when done with, would depend on the circumstances of the moment.

There are difficulties, however, in assuming that these large and uncouth implements were made by the natives now in possession of the country. These particular implements are not found outside the gibber, or tableland, country,(4) and they belong to particular types, which, so far as I am aware, have not been manufactured by the Aborigines of Australia within modern times.

(b) AN HYPOTHESIS CONCERNING THE TASMANIANS.

The possibilities of these implements having been made by an earlier race than the existing Australian natives opens up an interesting enquiry If such an earlier autochthonous people existed in Australia, it is natural to suppose that the Tasmanians were that people.

It would be beyond the bounds of our subject to review the many and conflicting theories that have been advanced as to the racial relationships of the Tasmanians and how they came to be in possession of Tasmania. That they reached Tasmania by sea seems improbable from physiographical and other reasons. With the exception of its northern coasts, Tasmania is faced by ocean deeps so profound that it is unlikely, during the human period, that there has been much more land above sea level, within a thousand miles of the island, than exists to-day. Moreover, the Tasmanian natives had not the skill to construct anything in the shape of a boat more than a very crude and temporary raft. Most writers believe that the Tasmanians reached their island home by way of the mainland of Australia [See I., p. 49; III., p. 955; IV., p. 265; VI., p. 730; VII., p. 72; XII., *(a)* p. 30; XIV., pp. 232, 233; XXIV., pp. 85, 86. Baldwin Spencer, Federal Handbook, British Assoc., Melb., 1914, p. 34. Sir William Turner, Trans. Roy. Soc. Edinburgh, xlvi., part 2, pp. 393, 394.]

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(4) This limitation in the distribution of the specimens may be explained, in part, from the fact that the lower ground is occupied by the river plains that have been built up by flood waters dating from a remote period. These sediments (which often take the form of drifting sand) have covered and obscured much of the ancient floor of the country.

Where successive waves of migration occur the inferior races are driven by the invaders, either up into mountain recesses or to the extremities of the land. The latter fate may have happened to the first occupiers of the Australian soil, while the geological incident of the submergence of the land, at the strait, and the conversion of the Tasmanian peninsula into an island, gave the remnants of this people the chance of survival. The absence of any evidences that the dingo found its way to Tasmania, leads to the inference that the separation of Tasmania from the mainland occurred at a date prior to the arrival of this animal on the southern coasts of Victoria.

It is generally admitted that the Tasmanian natives represented one of the most primitive and generalized types of mankind. Their low development, as evidenced in the manufacture of their weapons and tools, indicates an isolation that must date back to a high antiquity. If they had a Negrito-Papuan-Melanesian origin, as appears likely from their racial characteristics,(5) they must have migrated from their ancestral home before the introduction of the bow and arrow among these peoples, as it seems very improbable that a people who once possessed this useful weapon could ever lose all knowledge of such a simple and effective contrivance.

In the event of the Tasmanian natives having reached their island home by way of Australia they must have left some evidences of their occupation of the mainland, if not in other ways, at least by their stone implements, which are practically imperishable. The question that arises is: Can there be a possible connection between these unique implements of the central tableland of Australia and the Tasmanian people? In pursuing this enquiry, the only basis for comparison that we possess is in relation to their respective artefacts in stone, the methods adopted in their manufacture, the range of differentiation in their types, and the consequent stage of culture indicated by the same.

(c) TASMANIAN STONE IMPLEMENTS.

The class of stone mainly utilized by the late Tasmanians, in the manufacture of their implements, was obtained, principally, from the shales of the Permo-carboniferous coal measures, that had been indurated and more or less metamorphosed into a cherty rock by the intrusive igneous dykes that are common in the country. Less frequently, quartzite, and a jasper-like rock, formed by the decomposition of diabase, were utilized for implement-making. Although possessing an unlimited supply of such basic igneous rocks which, on the mainland, supplied the Australian natives with the raw material for the making of their polished tomahawks, the Tasmanians never got so far as to use this common stone of their own country for such a purpose. They had only a limited range, as to types, in the making of their implements, the shape appears to have been indifferent, the object aimed at was a cutting or scraping edge.

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(5) Mr. Churchward holds the view that the Pygmies of Central Africa are the nearest living representatives of Primitive Man. He says, "It was in Africa that the little Pigmy was first evolved from the *Pithecanthropus erectus*, or an anthropoid ape" [I., p. 12]. He also regards the "extinct Tasmanians as highly-developed Pygmies" [*loc. cit.*, p. 19].

Dr. F. Noetling, in an important paper [xii., *(a)* p. 1, *(b)* p. 14] on the Tasmanians, divides their implements into two classes, as follow:—"There is a large group of implements which leaves no doubt that it was the intention, the will of their makers, to produce a certain, well-defined form. These implements bearing evidence of the intention or will to produce a certain shape may be conveniently termed: Morpholithes. The other large group represents all those numerous, shapeless implements, which bear no evidence of the maker's will or intention to produce a definite shape. This group of implements may fitly be termed: Amorpholithes" [xii., *(a)* p. 1]. It is to this latter class that Dr. Noetling refers most of the Tasmanian implements. He says, "If we examine any larger collection of implements made by the Tasmanian Aborigines, the most striking feature we notice is a bewildering mass of forms, none of which are exactly alike, and the total absence of any definite intentional or conventional shape. We may examine them over and over again; there is a sort of general likeness, a family likeness, so to speak, but each specimen constitutes an individuality of its own, different from all the others. This absolute want of any intentional shape at once fixes their position in the scale of evolution, and they must be considered as belonging to the first and lowest group of stone implements, *viz.*, the Amorpholithes." [xii., *(a)* p. 7.]

The testimony as to whether the Tasmanians, in any case, ground the edges of their cutting tools, is conflicting. Brough Smyth says, definitely, "I can state with certainty that not one has been ground, and that no attempt has been made, in any case, to give an edge by grinding." [xxiii., p. 403.]

Prof. E. B. Tylor quotes Dr. J. Barnard Davis with reference to Tasmanian works of art in his possession as follows.—"Among a few exceedingly rude stone-chippings or implements made from a dark-coloured chert . . . . I have a more finished stone implement of an oblong form with one extremity slightly sharpened by grinding, which was employed by the women, without any handle, in notching the bark of trees up which they climbed in an ingenious manner in search of the opossum." [XXVI., p 148.]

At a later date [XXVII., pp. 339, 340] Dr. Tylor was able to trace the particular specimens on which Dr. Davis founded his statements, and has proved, definitely, that the supposed Tasmanian implement, "sharpened by grinding," was not Tasmanian in origin, but a typical "tomahawk" of Australian Aboriginal workmanship.

On the disputed question as to whether the Aborigines of Tasmania hafted their choppers, or ground the edges of their tools, the Royal Society of Tasmania instituted inquiries from all reliable sources. At a meeting of this Society held on June 10, 1873, the members, after a general discussion on the subject, recorded their conclusions in the terms, "The general belief of the Fellows present was that the stone axe with the handle attached was never used by our natives until taught by those from the neighbouring continent." [XXII., pp. 22-25; see also XXVI., p. 146.]

At the following meeting of the Society an important letter, written by Mr. Jas. Scott, was read, and was followed by the official statement, "All enquiries on the subject of the stone implements of the Tasmanian Aborigines tend to prove that no true tomahawks were known to, or fabricated by them. They merely used sharp-edged stones as knives. These were made sharp, not by grinding or polishing, but by striking off flakes by another stone till the required edge was obtained. As a general, if not invariable rule, one surface only was chipped in the process of sharpening." [XXII., p. 25.]

The confusion seems to have arisen from the fact that, about the year 1822, a number of Australian blacks were sent from New South Wales to Tasmania. The latter probably took some of their stone implements with them and, in intercourse with the Tasmanian natives, imparted to them the knowledge of improving the cutting edges of their stone implements by grinding, and also showed them the advantages of mounting their choppers in handles. Dr. Noetling has described and figured [XVI., XV.] some ground pebble-stones which he refers to Aboriginal workmanship, not designed for tools of any kind, but as "sacred" or "magic" stones. On the further point, as to the general idea that the Tasmanians trimmed their cutting tools on one side only, Dr. Noetling has shown that there were exceptions to this rule, and gives figures of several examples in which the trimming has been done on both sides of the edge; "but," he says, "this class of implement is very rare." [XIII.]

(d) THE TASMANIAN STAGE OF CULTURE.

Few, if any, people that have survived in a savage condition to historical times, have possessed so limited a range of appliances as the natives of Tasmania. The only wooden implements that they possessed were:—*(a)* a long stick, pointed and hardened by fire at one end, and used as a spear; and *(b)* a so-called "waddy," which seems to have been used chiefly in hunting game. When fighting, in addition to their wooden spears, they are said to have picked up and thrown at the enemy any loose stones that might be at hand. They had, therefore, little use for stone implements. A rough pebble, picked up on the beach, sufficed for breaking open shell-fish or crushing marrow bones. Their requirements, so far as stone implements were concerned, seem to have been, to make nicks in the bark of trees to assist in climbing; cutting down the long, slender stems of the *Melaleuca* for their spears; cicatrization; dividing up carcases; crescentic ("hollow") stone scrapers were used to scrape off the bark and give smoothness to their spears, and a stone scraper, with bevelled edge, was used in the preparation of animal skins. As prepared tools, they may be reduced to two primary types: *Cutting Tools* (which might be utilized in many incidental ways), and *Scraping Tools*, for shaping wood implements or removing fat, etc., in the curing of skins.

After eliminating the foreign elements from the Tasmanian artefacts, referred to above, what remains to the Tasmanian Aborigine is a stone-cult of the simplest and most limited character. Dr. E. B. Tylor says [xxvii., p. 340], "So far as stone-implement-making furnishes a test of culture, the Tasmanians were, undoubtedly, at a low palaeolithic stage, inferior to that of the Drift and Cave men of Europe."

For many years the oldest types of stone implements were known as "palaeoliths." They exhibited very definite types within a limited range of variation, as to form, and as they were usually found (other than in caves) in the older river drifts, implements of this particular type were generally associated with such deposits and are often spoken of as "drift" implements. In later years, worked stones that were different from the "drift" type, but still very ancient and associated with the remains of extinct mammalia, were found in England and, more particularly, on the Continent, which necessitated the subdivision of the Palaeolithic Age into several successive stages, linking the earliest palaeolithic groups with the dawn of the Neolithic Age. The chronological data, marking off these successive stages, have been worked out, principally, in relation to the prehistoric remains in France and Belgium.

At the same time, many investigators in prehistoric archaeology have claimed to have discovered still earlier examples of human workmanship which have come to be designated, "prepalaeoliths" or "eolithic" implements.

In 1889, Professor Joseph Prestwich described some remarkable prehistoric finds that had been made on the chalk plateaus of Kent [xvii.]. This paper was followed by others, by the same author, in succeeding years [xviii., xix.], and introduced what has become a considerable literature on the subject. Whilst the previously recognized palaeoliths were found in the gravels of the river valleys, this new find was obtained from certain ancient gravels that were laid down before the valleys containing the palaeolithic implements had been excavated. Of these plateau implements, Prestwich says, "They form a distinct group, characterized by their generally brown and ochreous colour, extremely rude shape, and worn appearance" [xvii., p. 286]. It is also stated that the great majority of the implements have been formed from natural fragments of flint. When design is indicated it is usually in the form of scrapers, or used for hammering, and are in all cases hand implements.

Professor B. C. A. Windle, of Birmingham University, describes this eolithic type of implements as "Roughly-hewn pebbles and nodules and naturally broken stones showing work, with thick ochreous *patina*, found on the plateaus of the chalk, and other districts, in beds unconnected with the present valley drainage" [xxix., p. 14]. The same author, when referring to the nature of the work done on these stones, says, "The trimming . . . . has generally been made on the edges of rude natural flints, taken from an old flint drift" [*loc. cit.*, p. 41]. Again, on page 43, Professor Windle says, "The stones are almost invariably stained a deep, warm, brown colour, in this respect resembling the flints of the drifts in which they are found. This colour spreads over the worked, as well as the unworked parts, though it may be lighter in shade on the former than on the latter."

Many experienced students in prehistoric archaeology are, however, sceptical in this matter and refer the chipped flints of the chalk plateau, and other places, as well as occurrences of similarly flaked flints at the base of the Pliocene "Crag," as having been caused by natural rather than by human agencies. The advocates for and against the validity of these supposed human artefacts are about evenly balanced. The Geological Society of London, on November 19, 1913, devoted an entire evening meeting to the subject. "No papers were read, but in response to the invitation issued on November 5, 18 or more exhibits were made of implements and reputed implements of Palaeolithic and earlier age, and of flints showing various types of fracture." A general discussion followed, in which the rival theories were about equally supported.

The latest attempt to discredit the so-called "eoliths," as man-made implements, is in a paper read before the Geological Society of London, by Mr. S. H. Warren, in January of the present year, on "A Natural Eolith Factory beneath the Thanet Sand." Mr. Warren made his observations on a section exposed in a chalk quarry, showing fractured flints caused by subsoil pressure arising from differential movement or creep [xxviii.].

The point of interest in these discussions, so far as the present paper is concerned, is that several authors have drawn comparisons between the Tasmanian stone implements and the eolithic, or prepalaeolithic, implements of Europe.

Mr. J. Reid Moir has attempted to give the genesis and development of human stone-artefacts in their successive stages, as follow [xi., pp. 38, 48, abbreviated]:—

1. The most primitive implement known is a tabular piece of flint with a hollow flaked out in one of its edges.

2. The next stage is represented by a similar piece of tabular flint in which two opposing hollows have been fashioned in its edges, producing a beak-like profile at the anterior region of the implement.

3. The beak-like profile, with its central ridge or gable, develops later into the rostro-carinate implement, that is triangular in transverse section and has its cutting edge on the dorsal surface. This is especially the type of the supposed implements that occur at the base of the Red Crag (Pliocene).

4. The rostro-carinate form passes, by lateral chipping, into the early palaeolithic side-scraper in which a cutting-edge extends continuously from the anterior to the posterior region.

5. The triangular section of the pointed eolithic and rostro-carinate implements is transformed, in the earliest palaeoliths, into a section which is roughly rhomboidal. The most highly evolved palaeoliths are those with straight symmetrical cutting edges, in which the rostro-carinate profile has almost disappeared.

6. The Chellean Stage. Pointed and ovate palaeoliths of complex section. Implements large and massive.

7. The Acheulean Stage. Pointed and ovate palaeoliths, elaborately flaked and of complex section. Implements getting smaller.

8. The Mousterian Stage. Scraper points and flake-implements of simple section. A few *coup-de-poings* (hand-

choppers) of complex section, with carefully chipped points and lanceolate flakes.

9. Magdalenian Stage. Scrapers, etc., of simple section and covering a variety of forms that were well finished by chipping.

The Magdalenian implements may be taken as representing the highest order and greatest differentiation of types within the Palaeolithic succession. What follows is the Neolithic, with its highly-finished chipped and polished implements.(6)

To which of these stages in the development of stone implements can the Tasmanian artefacts be most consistently referred? Professor Sollas says, "The Tasmanians, though recent, were at the same time a Palaeolithic, or even, it has been asserted, an 'Eolithic' race . . the most unprogressive in the world, which, in the middle of the nineteenth century, was still living in the dawn of the Palaeolithic epoch . . . The question as regards the 'implements' is an extremely difficult one. A great number of the Tasmanian forms are so rude and uncouth that, taken alone, we should have little reason to suspect that they had been chipped by man. . . . If we judge the Tasmanian implements by the best examples, we should, in fairness, extend the same treatment to the plateau 'implements.' The best of these do, indeed, show some superficial resemblance to the Tasmanian, especially in general form, and this is particularly true of the hollow scrapers." [xxiv., pp. 70, 89-90].

It stands to reason that some crude examples of stone chipping must occur throughout the whole range of the Stone Age. Many stones, after testing, would be found unsatisfactory and be rejected without any attempt to complete the implement. Youths would have to learn the art, and their earlier attempts must account for many failures. The most expert manipulator would, sometimes, roughly edge a stone for immediate use and then discard it. Such considerations explain the commingling of roughly chipped and undefinable forms occurring in association, at times, with the most highly finished implements. The stage of culture, indicated by any particular group of artefacts, is determined by the highest and most characteristic types in the group. Thus the polished implement clearly defines the Neolithic stage, while the relative diversity of type-forms and the finish shown in the workmanship are made the basis in distinguishing the respective stages that preceded the Neolithic standard.

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(6) A succinct account of the Palaeolithic stages and their typical implements will be found in the work of Professor Sollas [xxiv.].

It is on the principle, just stated, that the Tasmanian standard of culture, in implement making, is placed at about the lowest level.

V. POINTS OF RESEMBLANCE BETWEEN THE TABLELAND IMPLEMENTS AND THOSE MADE BY THE TASMANIANS.

In making this comparison, the great difference between the raw material available in the tableland country and that possessed by the natives in Tasmania must be taken into account. After examining the collections as exhibited in the museums of Tasmania and elsewhere, and from descriptions given by various authors, together with the figures published in the works of Brough Smyth [XXIII.], Dr. Tylor [XXVI.], H. Ling Roth [XXI.], Dr. Noetling [XII., XIII.], and others, it is impossible not to be struck with many points of similarity which the Tasmanian stone implements bear to those found in the gibber districts of Central Australia. The general points of resemblance between these two classes of implements may be summarized as follows:—

1. The utilization of conveniently shaped stones in their natural condition, more or less trimmed by chipping.

2. Implements of large size, usually with cortical surfaces, crudely shaped by flaking.

3. A flat ventral surface, often showing conchoidal fracture. Mr. R. M. Johnstone says, "From a study of a very large number of these flints the author has observed one general character common to them all, *viz.*, that whatever lack of symmetry they present in facial outline, one of the faces is almost invariably smooth and flattish, without marks of chipping" [VIII., p. 335].

4. Absence of any clearly-defined specific types, such as occur in the higher orders of stone implements. Mr. Johnstone says, "As a rule the flints have no definite form, being irregularly ovate-round, wedge-shaped, or spatulate" [VIII., p. 336].

5. Tendencies towards either quadrately or triangularly shaped implements.

6. Frequent occurrence of crescentic or hollowed scrapers —a prominent point or "beak" separates the two.

7. Hand Choppers, large, and roughly chipped.

8. Generalized types, the same tool having been used for various purposes, such as, indifferently, either for cutting, scraping, or chopping.

9. Absence of grinding or hafting of tools. All implements were intended and shaped for hand-use simply. Mr. Johnstone says, "It seems to be the prevailing opinion among those who had the best opportunity for observing, that the

Tasmanian natives were not in the habit of attaching handles to their flint hatchets, or other implements, as was the case among the Australian natives" [VIII., p. 335].

VI. SUMMARY AND CONCLUSIONS

The tableland country of Central Australia forms a very distinct geographical province and represents a residual land surface of very ancient topographical features. So far as evidences are available the country has not been below the sea since Cretaceous times. The "tableland" probably had its origin in a previous geographical cycle. The rivers, at the present time, spread their sediments over a relatively flat country, at lower levels than the old "table-top" hills that are residual of an earlier alluviation.

With the waste of the softer beds that underlie the siliceous capping of the "tabletops," the latter is broken up and the loose stones are gently let down, by waste, to lower levels, forming the great stony deserts of the interior. On this ancient land-surface are found worked stone implements of particular types.

These implements, in their characteristic forms, do not bear any close resemblance to such as are in use by the present native tribes of Australia. Many of the stone implements used by the Australian Aborigines are crude in the extreme, and some such have even been hafted; but, in contrast to these, many have been very finely finished. Their polished axes, symmetrically chipped spear points, hafted knives, and womerah chisels, may distinguish their artefacts as Neolithic in type, although representing a stage below that of the Neolithic art seen in the prehistoric remains of the latest Stone Age in Europe.

The implements that occur among the gibber stones of the tableland are, commonly, of large size and possess certain characteristics that are described in this paper.

It is possible, that the peculiar features of the stony deserts of Central Australia, and the nature of the raw material available there, may have given rise to the use of certain stone implements, in a local way, by the present native tribes of Australia that was not represented elsewhere in the continent.

Whilst these implements do not show a close resemblance to those now, or lately, in use among the Australian Aborigines, they afford numerous analogues with the stone implements that were in use by the late Aborigines of Tasmania.

This similarity of workmanship may be taken, so far as it goes, as presumptive evidence of a relationship as to origin.

It seems most probable that the Tasmanians found their way to the extreme south of Australia by way of the mainland, before the separation of Tasmania from the larger land mass.

If the Tasmanians were the true autochthonous inhabitants of Australia, it is reasonable to suppose that they would leave behind them some memorials of their occupation. The only class of remains that would be likely to survive so long a period, since their departure, is that of their stone artefacts, and it must be conceded that the conditions that have prevailed over the tableland area for an immense period of time must have been favourable for the preservation of such remains.

The considerable age of these human relics is evidenced by their highly-coloured cortex, or skin, which the most of these implements exhibit; and, also, by the natural glaze that has been developed over the surface of the worked stones, which, in many cases, has softened the outlines of the scars left by the respective flaking and chipping.

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VIII. DESCRIPTION OF PLATES.

All figures are reproductions from photographs taken by the Author. Measurements lineal.

Plate XI.

Photographic view of "gibber" country (stony desert), with a residual "tabletop" seen in the distance. Taken near Macumba Head Station. It was from this ground that the examples from Macumba, mentioned in this paper, were gathered.

Plate XII.

Fig. 1. Claw-shaped Implement. Reduced half. Stuart Creek. See Type No. 1, p. 211. [Compare ix., p. 321, figs. 33-35.]

Fig. 2. An Eolithic type of Implement with hollow scraper and cutting edge. Natural size. Stuart Creek. See Type No. 8, p. 213.

Fig. 3. Rostro-carinate Implement. Rather less than natural size. Stuart Creek. See Type No. 5, p. 212.

Fig. 3*a*. Side view of above showing the rostro-carinal ridge and beak in section.

PLATE XIII.

The figures on this plate illustrate various forms of pointed, or "beaked," Implements with scraper features.

Fig. 1. Strongly "beaked" Scraper with uniform large chippings making an almost circular Implement. Rather under natural size. Macumba. See Type No. 10, p. 213.' [Compare I., pl. 2; also XII., *(a)*, figs. 25-28.]

Fig. 2. A Tasmanian Pointed Implement introduced for comparison. The stone is a thick, dark-red jasper, with white blotches and shining lustre. A conchoidal fracture, in one plane, forms the under-side, while the upper has been roughly shaped into a subhemispherical outline. A main feature is the development of a prominent point at the distal end, bordered by a double scraper, one on either side of the point. On the right-hand side, a secondary point is also developed bordered by two hollow scrapers. The proximal end is thick. The similarity of this Implement to many of the tableland forms is self-evident. The figure is a trifle under natural size. The specimen was obtained in Tasmania by the writer and is in his possession.

Fig. 3. A flat Implement worked into points and concave (hollow) scrapers. The stone is a very fine-grained Desert Sandstone. The under-side is formed by a smooth conchoidal curve that covers half the surface, the remaining portion being chipped to reduce the face to a common level. The chief point occurs at the distal end with two carefully-chipped concave scrapers on either side. If the Implement be revolved through an arc of 90°, from right to left, another point, bordered by finely-worked scrapers, forms a feature similar to the first described. The whole edge of the Implement has been worked. The upper-surface has been chipped, apparently to reduce the thickness. The stone is of a reddish colour and has a distinct glaze. Natural size. Stuart Creek.

Fig. 4. A carefully-worked Implement consisting of points, claw, and scrapers. The under-side is formed by a single, convex, conchoidal fracture, that was formed by flaking from a previously-made, striking platform. At the distal end is a well-shaped point, bordered on either side by concave scrapers. With the exception of the proximal end, the whole edge has been worked, developing special features, including a "claw" on the left side, near the base of the tool. The upper-surface has been shaped, mainly, by two concave, smooth fractures. The stone is a very fine-grained variety of Desert Sandstone, is highly coloured—almost black on the worked edge. *Patinal* glaze strongly marked. It has the appearance of great age. Natural size. Stuart Creek.

PLATE XIV.

Fig. 1. A roughly-triangular Pointed Implement, with concave scrapers of varying sizes. Shows much fine chipping. Natural size. Stuart Creek. See Type No. 3, p. 212.

Fig. 2. An Ovately-shaped Implement with serrated edge, probably used for both cutting and scraping. Rather under natural size. Stuart Creek. See Type No. 11, p. 214. [Compare V., fig. 42; also XII., *(a)*, figs. 12, 14.]

PLATE XV.

Fig. 1. Knife and Hollow Scrapers, carefully worked. Point developed by notch. A little more than natural size. Stuart Creek. See Type No. 9, p. 213.

Fig. 2. A combination of Duck-bill and Hollow Scrapers. The stone is a light-coloured variety of Desert Sandstone, destitute of desert colouring and *patina*. The under-side has been formed by striking off a single flake, leaving a flat surface. Upper-side shaped by numerous chippings directed from a central ridge. Edge very finely worked to a symmetrical outline. This is a spatulate form of scraper which occurs as a Tasmanian type and is represented in prehistoric stone implements in many parts of the world. The specimen has a more modern appearance than most of the tableland forms. A little more than natural size. Stuart Creek. [Compare XII., *(a)*, fig. 23. For pygmy examples see I., pl. 1.]

PLATE XVI.

Lozenge-shaped Implement formed by the removal of a few large flakes, and finished off by very fine chippings on the edge. A notch has converted the remote angle into a well-defined point. Natural size. Macumba. See Type No. 4, p. 212.

PLATE XVII.

A Hand Chopper formed by utilizing a thinnish shell that exfoliated from a block of Desert Sandstone. The cutting edge is limited to one side. A slight notch at the remote angle has developed a low point. About three-fourths natural size. Macumba. See Type No. 13, p. 214.

PLATE XVIII.

A roughly-shaped Knife with cutting edges on two sides. Chipped edge mostly on dorsal surface, but, in places, is improved by chipping on the under-side. Highly coloured and glazed. Slightly enlarged. Stuart Creek. See Type No. 2, p. 212. [Compare XX., p. 13, fig. 6, figured as a "Levallois *pointe de lance*."]

PLATE XIX.

Roughly-executed Hand Chopper with cortical surfaces on both sides. The chipping done to produce a cutting edge is unusually large and has been carried out, alternately, on the upper- and lower-surfaces so as to produce a wavy cutting edge, which was evidently intentional. About three-fourths natural size. Macumba. See Type No. 14, p. 214. [Compare V., fig. 31.]

PLATE XX.

An Implement of the *coup de poing*, or "boucher," type, with a flat ventral side instead of being biconvex. The proximal end retains the cortical surface of the above, and is well formed for gripping by the hand. Rather more than three-fourths natural size. Macumba. See Type No. 15, p. 215. [Compare XXVII., pl. 11, figs. *7a*, *7b*.]

PLATE XXI.

A Hand Chopper that bears a certain resemblance to the Australian "tomahawk," but has been worked from a fragment of Desert Sandstone. The cutting edge (the upper part in the figure) is bevelled on both sides and is almost smooth, as though having been ground. If it be a ground Implement its relationship to the Australian tomahawk is self-evident. Slightly enlarged. Stuart Creek. See Type No. 16, p. 215.

ONCHOCERCIASIS OF QUEENSLAND CATTLE.

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University, Brisbane.

(Communicated by Professor Cleland, M.D.)

[Read October 13, 1921.]

In the present paper no less than three distinct species of *Onchocerca* are recorded as parasites of the connective tissues of Queensland cattle, *viz.*, *O. gibsoni*, Cleland and Johnston; *O. gutturosa*, Neumann; and *O. lienalis*, Stiles. A reference is also made to *O. fasciata*, Railliet and Henry, which infests camels.

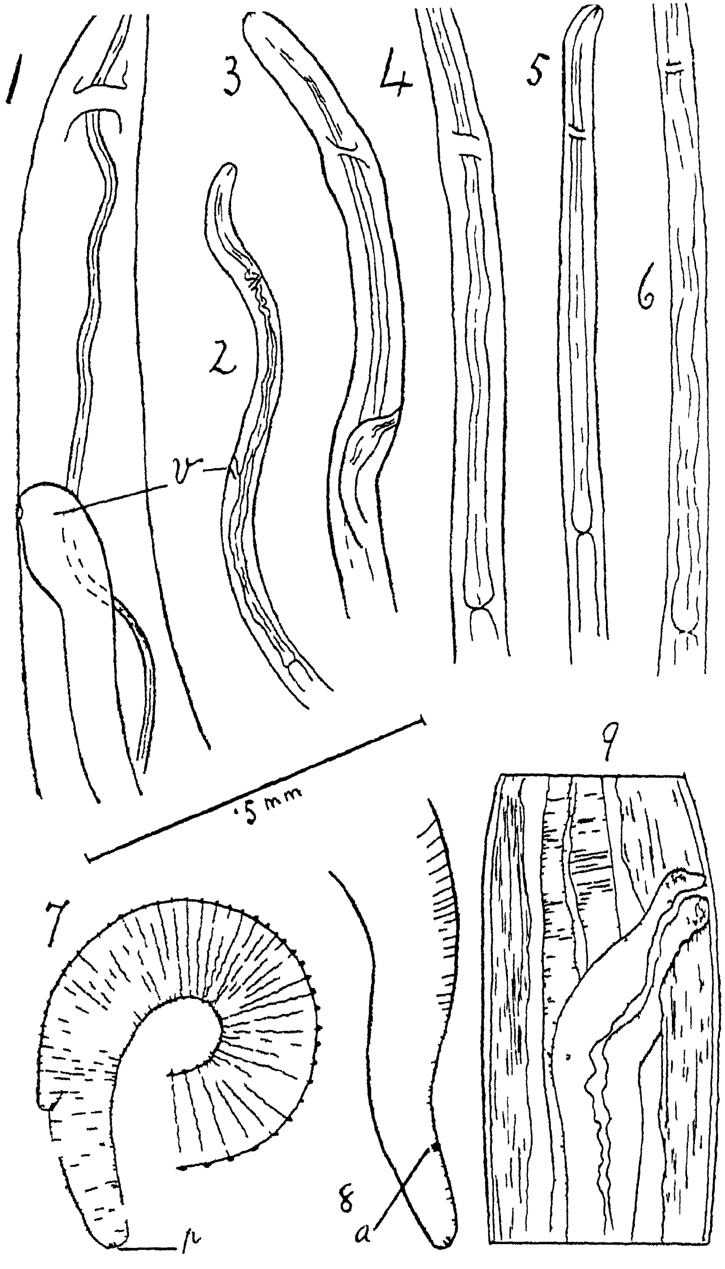
ONCHOCERCA GUTTUROSA, Neumann, 1910.

Figs. 3, 4, 7, 9, 10, 13, 16, 18, 19, 20, 25.

In a recent paper (Johnston and Bancroft, 1920a, p. 40) it was pointed out that, in addition to the well-known nodule-producing worm, *Onchocerca gibsoni*, a second species of the genus was to be met with in cattle in Queensland and New South Wales. It was provisionally identified as *O. bovis*, but shortly afterwards (J. and B., 1920b), in a summary of that paper, it was definitely labelled as belonging to Piettre's species.

In Australian cattle the parasite is to be found in the neck ligament between the first and fifth dorsal vertebrae; also at the level of the trochanter between the ends of the tendons which are attached in that region. The tendons at the stifle joint are also at times infected. Though a fibrosis is set up as a result of the presence of the parasite, yet the lesions are usually not extensive and do not assume the nodular form, so typical of *O. gibsoni* and *O. indica*. The worms occur more or less tangled lying in a fibrous tunnel, and considerable lengths of the female may be extracted from the surrounding fibrosed tissue before breaking takes place. Males lie loosely coiled or tangled in spaces adjacent to the females, or at a little distance, and can readily be obtained entire. Disintegrating worms undergoing calcification may be met with.

The writer has been informed that the parasite may be found in a very large percentage of cattle slaughtered at the Abattoirs in Brisbane and Rockhampton, so that it is, probably, very widely distributed in Queensland. It occurs, not uncommonly, in cattle slaughtered in Sydney. Mr. N. V. Brown, to whom I am indebted for specimens and information, informed me that he had not observed it in


v
·5 mm
a
p

cattle killed in the Melbourne Abattoirs. Piettre (1912) recorded the presence of *O. bovis* in 26 out of 30 cattle examined in France, and in the cervical region of 65 per cent. to 70 per cent. of Argentine animals and of 90 per cent. of Uruguayan cattle killed at the meat preserving works in those two countries (Piettre, 1916; Joan, 1917). Emery (in Neumann, 1910, p. 270) reported that *O. gutturosa* was to be found in the connective tissue of the neck ligament, principally on the inner face, and especially at the level of the second and third dorsal vertebrae in Algeria and Tunis, where, he states, nearly all adult bovines harbour the parasite. It is worthy of note that Piettre (1912) failed to find *O. bovis* in the cervical ligament of French cattle, though he recorded it from the stifle joint and from the tibio-tarsal ligament.

We have not been able to determine the length of the female worm. Joan (1917, p 448) gives it as being over 60 centimetres in Argentine specimens. Piettre found that in French specimens the total length of fragments exceeded 26 cm., while in Argentine worms (1916) it was about 70 cm.

Males (from Queensland cattle) measured from 24 to 33 mm. in length. Piettre gives 40 to 50 mm. in the case of French material. T. Joan mentioned that one of the males studied by her measured 57·5 mm.

Description of Female.

Figs. 3, 7, 9, 16, 18, 19, 25.

The female body tapers gradually towards the anterior end, but rather abruptly at the posterior extremity.

The head end (figs. 3, 16) is gently rounded in front and, at least in some specimens, appears to possess a few minute papillae. The cuticle is smooth as far back as the region of the termination of the long oesophagus. The width of the body in front of the nerve ring is from ·05 to ·06 mm. In the region of the latter there is a dilatation, so that the body measures ·07 to ·075 mm. in diameter. Behind this it narrows slightly to become again somewhat dilated at the level of the vagina, where the body diameter reaches ·070 to ·085 mm. The first (cervical) dilatation is situated at from

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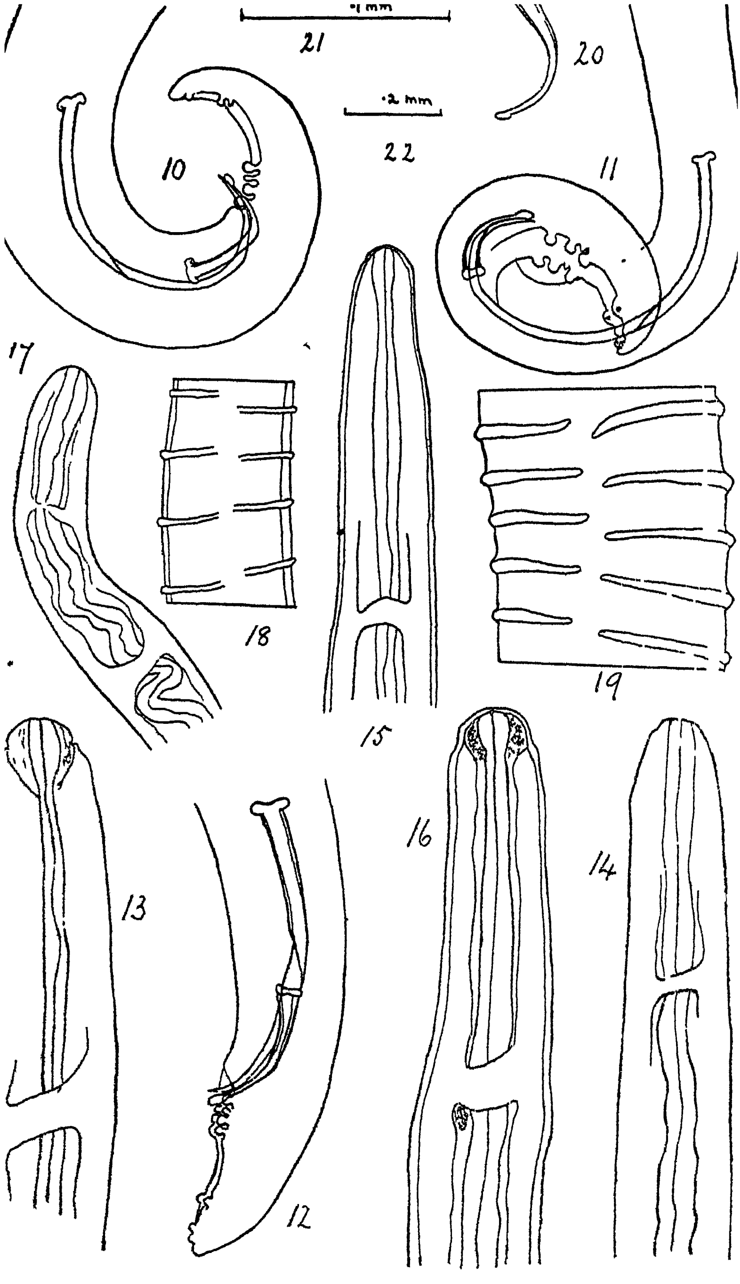
Figs. 1 to 3, heads of females. 1, *O. gibsoni.* 2, *O. lienalis.* 3, *O. gutturosa.* 4 to 6, heads of males. 4, *O. gutturosa.* 5, *O. gibsoni.* 6, *O. lienalis.* 7 and 8, female tails. 7, *O. gutturosa.* 8, *O. lienalis* (ridges only roughly and partly indicated). 9, part of *O. gutturosa*, showing female aperture. *a*, anus; *p*, papilla; *v*, vagina. Figs. 1 to 8, drawn to the scale indicated; 9, drawn about four times that scale.


·1 mm
·2 mm

·20 to ·25 mm. from the anterior end, while the second, *i.e.*, that in the vaginal region, occurs at ·50 to ·60 mm. from the mouth. At ·15 mm. from the anterior end, *i.e.*, in the region of the termination of the oesophagus, the body diameter is ·08 mm.

The posterior extremity (fig. 7) is strongly ringed to the tip. The anus lies at about ·22 mm. from the termination of the worm, the body width there being about 0·8 mm. Immediately in front of it the diameter is about ·1 mm. Behind the anus the body gradually tapers to end in a bluntly rounded tip with a diameter of about ·05 to ·06 mm. The end of the tail possesses a tiny rounded projection at its termination and there is a pair of very minute papillae situated rather on the ventral aspect in front of it. Joan detected one pair in Argentine specimens, and Neumann figured a pair in the Algerian species.

The body, except in the anterior region, is marked by well-developed spiral cuticular ridges, which vary in their prominence and closeness of arrangement according to the body region (figs. 18, 19). They are generally from 4 to 6 micra in height, but vary in width from 6 to 15 micra. The distances between the spirals increase with the body diameter. Thus, where the latter is about ·110 mm. the ridges are about 20 μ apart; when ·115 to ·120 mm., they are 25 to 35 μ apart (figs. 19, 26); ·130 mm., 30 to 45 μ apart; ·230 to ·250 mm., about 60 to 80 μ apart (fig. 25); when ·280 mm. (the maximum diameter of the female worm), the ridges are from 95 to about 120 μ distant (occasionally as much as 140 μ) from each other (fig. 18). At 3·5 mm. from the posterior extremity, the body diameter is ·26 mm. and the low ridges are ·07 mm. apart; at one millimetre from the tip the measurements are ·13 and ·03 respectively; and at ·5 mm. they are ·12 and ·01 respectively. The ratio of the distance between ridges on the mid-body to the diameter of the mid-body is from ·33 to ·43.

The ridges have a slight wavy outline owing to the presence of tiny prominences on them and, at first sight, seem to be arranged in a simple spiral, but they are at least on a great part of the body, apparently along the lateral lines (figs. 18, 19), interrupted in a manner somewhat like that

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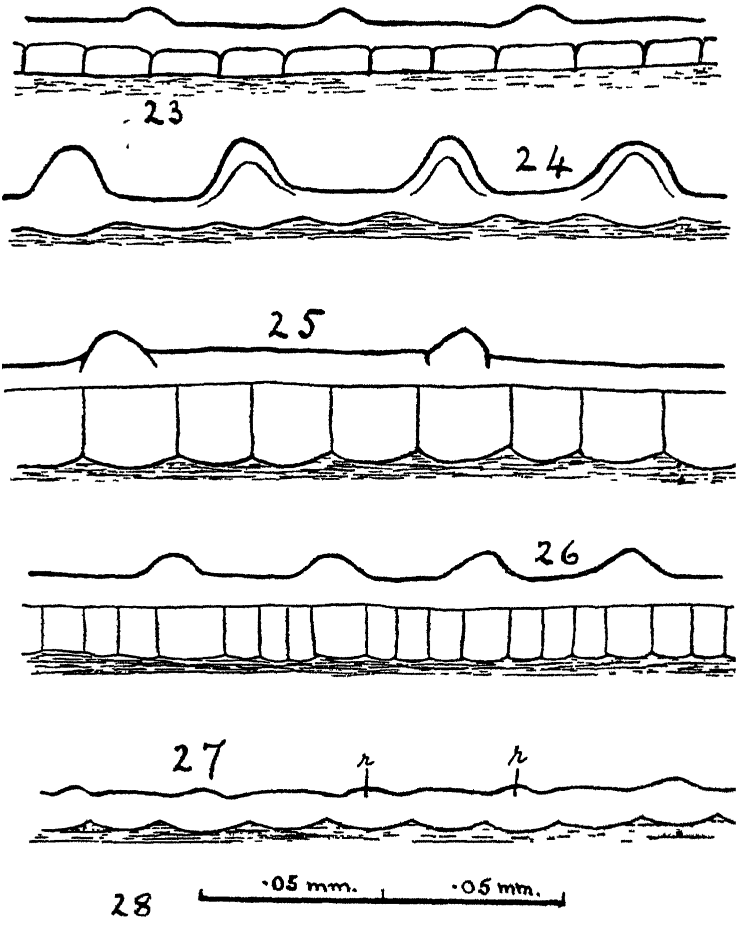
Figs. 10 to 12, tail ends of males. 10, *O. gutturosa*. 11, *O. lienalis*. 12, *O. gibsoni*. 13 to 15, heads of males. 13, *O. gutturosa*. 14, *O. lienalis*. 15, *O. gibsoni*. 16 and 17, heads of females. 16, *O. gutturosa*. 17, *O. lienalis*. 18 and 19, parts of body of female *O. gutturosa*. 18, body width, ·270 mm. 19, body width, ·120 mm. 20, small spicule of *O. gutturosa*. 21, scale to which figs. 10 to 17, 19, 20 were drawn. 22, scale for fig. 18.

figured (probably diagrammatically) by Joan for *O. bovis* (Argentine material), and exactly like that indicated by Neumann (1910, p. 275) for *O. gutturosa.* The arrangement of the ridges varies, then, according to the position from which they are viewed.



Figs. 23 to 27, views of side of females (optical section) to show thickness of cuticle, height of ridges, striae, etc.; all figs. drawn to scale indicated in fig. 28. 23, *O. fasciata* (diameter of body at place figured, ·41 mm.). 24, *O. gibsoni* (·50 mm.). 25, *O. gutturosa* (·230 mm.). 26, *O. gutturosa* (·120 mm.). 27, *O. lienalis* (·20 mm.); *r*, ridges.

The outer layer of the cuticle on the greater part of the female worm measures about 10 μ in thickness between the ridges. The underlying region is about 20 μ thick and is subdivided between each pair of ridges, usually into three (occasionally four) ring-like segments and there is one below each ridge (figs. 25, 26). From the apex of one ridge to that of the next one there are, then, three complete and two half rings of the under-cuticle, just as figured by Neumann. Thus there appear four striae between the ridges. Joan (p. 447) figures eight such secondary annulations and nine striae as occurring between the main ones, the latter being 127 μ apart and the former 15·5 μ. In our specimens the secondary rings measured from 7 to 10 μ (the main rings, *i.e.*, those below the ridges, being rather wider than those intervening), when the ridges were 45 μ apart; and about 20 μ in width when the summits of the ridges were 95 μ distant from each other.

The mouth is immediately followed by the long tubular oesophagus, about 1·52 mm. long and measuring from 12 to 18 μ in diameter in front of the nerve-ring and 22 to 25 μ behind it. Surrounding the anterior end of the oesophagus there is a mass of cells which appear to be glandular The intestine does not call for comment.

As already stated, the position of the nerve-ring corresponds with the anterior dilatation of the body and lies at about 220 to 240 μ from the mouth. The excretory pore appears to be situated in this region. The thick-walled vagina opens at the level of the second dilatation, about ·50 to ·57 mm. from the anterior extremity of the worm (fig. 9). Uterine eggs, containing fully-developed larvae, have very thin shells and measure 32 to 37 μ in their major diameter and 23 to 30 μ in their minor axis. Larvae found free in the uteri have a length of about ·20 mm and a breadth of 5 μ, the anterior end being bluntly rounded and the posterior pointed.

Description of the Male.

Figs. 4, 10, 13, 20.

The male worm maintains a comparatively even diameter throughout, being ·05 to ·06 mm. in front of the nerve-ring which lies at ·18 to ·20 mm. from the anterior end, gradually widening to ·08 to ·09 mm., and maintaining the latter breadth until near the posterior extremity. At the level of the anus the diameter is ·04 mm., the worm gradually tapering to the tip. The anterior dilatation in the vicinity of the nerve-ring is very slight, the diameter of the parasite there being about ·065 mm. The second dilatation of the female is not represented. A few tiny papillae appear to be present at a little distance behind the mouth. Cuticular ornamentation is hardly recognizable even under the oil immersion. The cuticle is very delicate, measuring about 2·5 to 3 μ in thickness.

The anterior end (figs. 4, 13) resembles that of the female, as also does the oesophagus, which has a similar diameter (10 to 12 μ), but the length is ·82 to 1·1 mm. The anus lies at ·075 to ·085 mm. from the tip of the spirally coiled tail.

The male papillary arrangement is usually as follows (fig. 10): four pair of perianal, of which the third pair are often rather smaller than the others; a post anal group of two, consisting of a smaller anterior papilla, lying just in front of, or beside, a larger one; and a caudal group composed of a prominent double one formed by the fusion of the pair (*i.e.*, one from each side), and there may, at times, be recognized a very small papilla on each side in front of it. The alae are rather narrow.

The longer spicule has an obliquely pointed end and measures from ·180 to ·255 μ in length, the breadth being 5 to 7 μ, while the shorter spicule is a thicker organ terminating in an enlarged rounded extremity. The shorter measures ·060 to ·080 mm. (generally about ·070) in length and 7 to 10 μ in maximum breadth (excluding the anterior expanded rim-like portion), its form tapering posteriorly so that the width is about 3 μ just in front of the widened extremity, which is about 5 μ across and 10 μ long (fig. 20).

If the information relating to this Australian species and *O. gutturosa* from Northern Africa, contained in the accompanying tables be compared, it will be noticed in regard to the males, that practically all the measurements agree except the lengths of the greater spicule, Neumann's maximum being longer than our maximum. In the case of the females the agreement is practically complete, the only marked differences being in regard to the diameters of the oesophagus and the cervical dilatation, these being of minor importance. It seems best to regard the Australian parasites as *O. gutturosa*, including under its synonymy *O. bovis*, Johnston and Bancroft, 1920 (*nec* Piettre, 1912). A specimen collected from an ox in Sydney Abattoirs and placed at our disposal through the kindness of Dr. E. W. Ferguson, Health Department, Sydney, was found to be specifically identical with the Queensland material.

The information available to the writer regarding *O. bovis*, Piettre, from French cattle is not sufficient to allow him to compare it with *O. gutturosa*. The site of infection varies, the latter being especially common in the neck ligaments, whereas the former is reported by Piettre as not invading that region. Neumann makes no reference to the presence of his species in any other location, but there is no evidence that it was looked for elsewhere. Piettre recorded *O. bovis* as occurring in the femora-tibial (stifle) joint of French cattle. The male of *O. bovis* is much longer and the female probably much shorter than those of *O. gutturosa*. The lengths of the male spicules, in the former, correspond with those of Australian specimens, but are less than those given by Neumann for *O. gutturosa*. In our earlier account it was mentioned that the female parasites were very like those of the Algerian species, but that the dimensions of the male spicules agreed with those of Piettre's species, hence our earlier determination. It must be left for some other investigator to determine whether Piettre's and Neumann's species are distinct.

The brief account (Joan, 1917) available regarding the South American parasite allows one to note certain differences from the Australian species. The males in the former are much longer and the papillae are said to be differently arranged, but in view of the difficulty sometimes experienced in detecting them, especially when the tail is closely rolled up, and in view of the variations in position (especially asymmetrical development) known to occur in the genus *Onchocerca*, further examination might reveal additional papillae. The South American female worms are recorded as being much longer than the French *O. bovis*, but agree more nearly with Neumann's account. The maximum diameter of the body and also the distance between the spirals are given as being about twice as great as in Algerian and Australian specimens. Besides, there are figured from six to nine striae between the ridges, whereas in the other cases there are from three to five. The egg is distinctly larger in both diameters, though not as large as given by Piettre for those of the French species.

It seems likely that the South American parasite is not *O. bovis*, but the available description does not allow one to synonymise it with *O. gutturosa*. The lesions and site of infection are similar to those of the Australian worm, as also are those briefly described by Ransom (1920, 1921), who reported that an *Onchocerca* occurred commonly in cattle slaughtered in Chicago. Whether the latter is *O. gutturosa* or the South American species has not been settled, though Piettre recorded as *O. bovis* parasites collected from frozen beef from Madagascar, Canada, and the United States.

ONCHOCERCA LIENALIS, Stiles, 1892.

Figs. 2, 6, 8, 11, 14, 17, 27.

In the former account (Johnston and Bancroft, 1920) mention was made that "*O. bovis*" was to be met with in Queensland cattle in the gastro-splenic ligament, and it was suggested that the species was probably identical with Piettre's. Recent examination shows them to be quite distinct.

O. lienalis is extremely common in cattle in this State, especially in dairying districts in the south-eastern portion of it. It has been stated to me that nearly 100 per cent. of cows and bulls and perhaps 50 per cent. of oxen slaughtered are found to harbour this parasite whose presence in Australia had not previously been noted. In the Rockhampton district the worm is very common, but apparently less so than in the south-eastern part of the State. Mr. N. V. Brown has informed me that it is commonly met with in cattle in New South Wales.

The female nematode is readily overlooked owing to its location in the connective tissue, between the stomach and the spleen, especially adjacent to the latter, where the tunnel enclosing the parasite, if noticed, would easily be mistaken for an empty blood-vessel. The organism lives in a very delicate worm-like fibrous tunnel in the connective tissue, this tunnel showing no tendency to become thickened except occasionally at the tail end of the worm. There is then comparatively little fibrosis and no typical nodule formation as the parasite does not roll itself up in the tissues, except sometimes at the extreme posterior end, where coiling may occur and a slight local thickening of the tissue become noticeable. A female specimen, measured *in situ*, reached 316 mm., while another (also *in situ*), whose extreme anterior end was missing, was 425 mm. long, its estimated length being 460 mm. Usually only two or three worms seem to occur in each host. Though every female examined (from about 25 different hosts) contained uterine larvae, in only one case was a male obtained.

As the worm has never been described, it seems advisable to place on record some data regarding it. Stiles named it *Filaria lienalis*, in 1892, from cattle in United States of America, but the description was lost during transit. In 1894 he referred to the parasite as *Spiroptera reticulata*. Both Leiper and Gedoelst, in 1911, placed it under *Onchocerca*.

Description of the Female.

The anterior end of the female is extremely delicate (figs. 6, 17) and it is a matter of chance whether one succeeds in obtaining the head. As only one such specimen was collected, the measurements are necessarily based on it and do not indicate any range of variation. The head end is bluntly rounded, and almost at once assumes a diameter of ·03 mm., reaching ·04 at the level of the nerve-ring (·16 mm. from the mouth). The increase in diameter is so gradual that at 40 mm. from the mouth it is only ·05 mm. Ultimately the width reaches a maximum of ·18 to ·20 mm. Towards the posterior end it tapers to about ·16 mm. (at ·6 mm. from the tip), then rather more quickly towards the tail (fig. 8). At the level of the anus (which lies at ·13 mm. from the tip) the diameter is ·065 mm. The extremity is bluntly rounded and possesses a pair of very minute papillae. *In situ* the tail end is sometimes found spirally rolled and lying in a little gland-like mass of fatty and fibrous tissue, but often occurs lying in line with the preceding part of the body

The ridges in this species are irregularly wavy and extremely low, their greatest height being under two micra (fig. 27). In the mid-region of the worm they are fairly regularly situated at ·030 to ·040 mm. apart. In the tail region they are very low and close. At ·6 mm. from its tip they measured ·015 to ·017 mm. apart (body width ·16 mm.). Between two adjacent ridges there are two striae and, sometimes, these latter are sufficiently pronounced to make it difficult to distinguish them from the low ridges, and then that portion of the worm seems to be minutely corrugated. The ratio of the distance between adjacent ridges on the mid-body, to the mid-body diameter, is only ·2 as against ·33 to ·4 in the case of *O. gutturosa*, and about ·08 to ·10 in *O. gibsoni*, where they are especially close.

The oesophagus is ·75 mm. long, its diameter increasing from ·015 to ·02 mm. as it proceeds posteriorly. The vagina lies at ·48 mm. from the anterior extremity.

Description of the Male.

The male is a very delicate organism, apparently inhabiting serous spaces in the connective tissues, not surrounded by a tunnel—in this respect resembling the male of *O. gutturosa*. The only specimen obtained—a broken one—measures 23·8 mm. in length and possesses an even diameter (·05 mm.) for nearly the whole of its length; narrowing gradually to the spirally-wound tail, the width at the cloaca being ·03 mm. It is worthy of note that the head end has, practically, the same dimension as that of the female.

The head (figs. 6, 14) is rounded and bears at least two, probably four, tiny papillae. Lips are not recognizable.

The annulations, though very minute and closely arranged, are readily visible under the high power. The cloaca lies at ·06 mm. from the tip of the tail. The nerve-ring is situated at ·13 from the mouth. The oesophagus has a width of ·018 mm., increasing to ·025 mm.

The alae are very narrow. There are four pair of perianal papillae, the first, second, and fourth pairs being large, the third quite small and situated rather inwardly from the remainder. The postanal pair are very prominent and there seems to be a tiny pair inwardly from, and just behind, them. There is a pair of large caudal papillae, very close together. The spicules are of the usual *Onchocerca* form, measuring ·240 and ·057 mm. in length, and ·006 and ·009 mm. in width, respectively (fig. 11).

Ransom (1920, 1921) sated that *O. lienalis* is common and widely distributed in the United States. It appears to be a parasite of no economic importance.

ONCHOCERCA GIBSONI, Cleland and Johnston, 1910.

Figs. 1, 5, 12, 15, 24.

The common worm-nodule producer *O. gibsoni*, occurring in cattle in Queensland, New South Wales, and the Northern Territory, has been described so often that there is little need to do more than call attention to a few points in structure in order that they may be compared with similar parts in the other two cattle-frequenting species under review. Most of these particulars are referred to in the accompanying tables.

O. gibsoni (female) is a much stouter parasite than the other two and its spiral ridges are much more pronounced, being considerably higher and with better developed prominences along the course of the spirals. The male of *O. gibsoni* is also a rather larger parasite, its minimum equalling the maximum of *O. gutturosa*, and its cuticle is distinctly ornamented, ridges being indicated even on the tail.

The ridges in the female were found to be usually situated at from ·05 to ·08 mm. apart in the mid-body where the diameter was about ·45 mm. The maximum height was from 12 to 15 micra. Between adjacent ridges there could be seen, in favourable preparations, two fairly well-marked striae, 25 to 30 micra apart (fig. 24).

The nerve-ring in the female figured lies at ·12 to ·15 mm., and the vagina at ·7 mm. from the anterior end. Both of these organs vary somewhat in regard to their positions in relation to the anterior end.

As already pointed out by Dr. Sweet, the male may possess a large papilla situated well in front of the cloaca. In a favourable preparation, generously placed at my disposal by Dr. Ferguson, such a preanal pair is followed by three perianal pairs, a well-marked postanal, and a caudal group of three pairs—one being a large precaudal pair, followed by two smaller pairs, close to the tip of the tail—making a total of eight pairs.

The amount of fibrosis of the surrounding connective tissues of the host seems to be related to the development of ridges on the parasite, there being extremely little fibrosis surrounding *O. lienalis*, whose ridges are very low; a greater amount surrounds *O. gutturosa*, and, at times, there may be a slight indication of nodule formation, while the strongly corrugated forms, like *O. gibsoni*, *O. indica*, *O. fasciata*, and *O. volvulus*, give rise to a well-marked nodule formation.

ONCHOCERCA FASCIATA, Railliet and Henry, 1910.

Fig. 23.

Attention was drawn by Dr. Cleland and the author, in 1910, to the presence of a worm nodule-producing *Onchocerca* (identified as being perhaps *O. gibsoni*) in camels imported from India into Western Australia. In the same year Railliet and Henry (C.R. Soc. Biol., 68, 1910, p. 250) gave the species the above name, describing it as follows:—Female alone known from fragments without extremities; thickness, 400 to 475 micra; cuticle with slightly undulating ridges, repeated at every two or three striae; from a subcutaneous nodule from the head of a dromedary, Punjab. [The host was incorrectly listed by Dr. Sweet (1915, p. 31) as *Camelus bactrianus*.]

In our original account (1910, pp. 177, 178, 189) we mentioned that the anterior end and body fragments of the female specimens, examined by us, showed similar characters and measurements to those of *O. gibsoni*, and that the vulva was similarly placed.

A re-examination of some fragments, collected by Prof. Cleland from Western Australia, and now in the writer's collection, shows that the maximum body diameter is from ·40 to ·45 mm., and that the irregularly sinuous and knobbed ridges are from ·07 to ·09 mm. apart (fig. 23). Between the ridges are two to four, usually three, striae. The ridges are from 7 to 9 micra in height on the mid-body. The larval measurements resemble those of *O. gibsoni*, *viz.*, length ·18 to ·20 mm., and breadth ·003 mm.

TABLE SHOWING COMPARATIVE DAT

The figures in parentheses are based on measurement
(relating to *O. gibsoni)* are taken from Dr. Swe

FEMALES.

	O. gutturosa, Australia.	() 1 (T
Length of female	?	
Diameter ·15 mm. from anterior end ...	·08	
Diameter just in front of vulva	·07-·085	
Diameter of mid-body	·250-·280	
Diameter at level of anus	·08-·10	
Diameter of cervical dilatation	·07-·075	
Nerve-ring from anterior end	·22-·24	
Oesophagus, length	1·52	
Oesophagus, diameter	·012-·018	
Vulva from anterior end	·55-·60	
Anus from posterior end	·22	
Cuticle thickness	·030	
Distance between spiral ridges on mid-body	·095-·120	
Ratio of distance between adjacent ridges on mid-body to maximum diameter of mid-body	·33-·43	
Number of striae between ridges	4	
Height of ridges on mid-body	·004-·006	
Egg (with larva), length	·032-·037	·(
Egg (with larva), breadth	·023-·030	·(
Free larva, length	·20	·!
Free larva, breadth	·005	

MALES.

	O. gutturosa, Australia.	C (:
Length of male	24-33	
Diameter ·15 mm. from anterior end ...	·05-·06	
Diameter ·5 mm. from anterior end	·05-·06	
Diameter of mid-body	·08-·09	
Diameter of level of cloaca	·03-·04	
Diameter cervical dilatation	·065	
Nerve-ring from anterior end	·18-·22	
Oesophagus, length	1·1	
Oesophagus, diameter	·010-·020	
Cloaca from posterior end	·075-·085	
Long spicule, length	·180-·255	
Short spicule, length	·060-·080	
Long spicule, diameter	·005-·007	
Short spicule, diameter	·007-·010	
Transverse ridges apart	·0015	
Papillae (adanal, postanal, caudal)	4, 2, 1 or 2	

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(1) In our original short account (Agric. Gaz., N.S.

RELATING TO ONCHOCERCA, SPP. SIZES IN MILLIMETRES.
s obtained from the authors' drawings (Joan, Piettre), while those in bra
et's paper (1915, pp. 44, 46), compiled from the work of various authors

FEMALES.

. *bovis*, France Piettre).	*O. bovis*, Argentine (Joan and Piettre),	*O. gutturosa*, N. Africa.	*O. lienalis*, Queensland.	*O. gibsoni*.
260+	600+-700+	550+	316-(460 ?)	[526-1403]
	(·06)	(·072)-·081	·04	[·049]-·13
	(·10)	(·09)	·04	[·106-·207]
·26-·29	·508	·30	·18-·20	[·37-·5]
	(·170)	(·07)	·065	[·175-·245]
	(·030)	·09-·10	Absent	Absent
	(·27)	(·28)	·16	[·102-·188]
·82-·85	1·262	1·15	·75-1·1	[·52-1·42]
	(·004)	(·036)	·015-·02	[·017-·052]
·63-·65	(·60)	·55	·43-·48	[·33-1·138]
	(·30)	·20	·13	[·175-·402]
	(·023)	·035-·047	·020	[·007-·01]
	·209	·090-·110	·040	·05-·08
	(·24)	(·33-·37)	·2	·11-·13
3	(6-9)	3-5	2	2
		(·006)	·002	·012-·015
48-·053	·038-·042	·035-·045	·038-·040	[·04-·045]
34-·036	·031-·035	·028-·035	·028-·030	[·03-·039]
230-·265		·170-·195	·240	[·22-·35]
·0055		·004	·004	[·003-·004]

MALES.

. *bovis*, France Piettre).	*O. bovis*, Argentine (Joan).	*O. gutturosa*, N. Africa.	*O. lienalis*, Queensland.	*O. gibsoni*.
40-50	57·5	28·3-33·8	23·8	[33-55]
	(·032)		·05	·038-[·066]
		·35 (? ·035)	·05	·061-[·085]
085-·095	·09	·09-·105	·052	·12-[·196]
	(·03)	0·58	·03	[·035-·056]
	?	·08	Absent	Absent
		(·35)	·13	[·14-·20]
750-·800		·95	·90	[·48-1·07]
	(·01)		·018-·025	[·015-·07]
	(·057)		·060	[·048-·087]
·180-·210	·216	·225-·295	·240	[·140-·220]
·065-·075	·078	·075-·088	·057	[·063-·094] (1)
	(? ·005)	(·01)	·006	[·005-·014]
	(? ·005)	(·015)	·009	[·005-·008]
·005-·006		·0015-·0018	·002	[·0045-·006]
4, 1, 2	4 (3 in text), 0, 2	4, 2, 1	4, 1 (? 2), 1	4, 1, 2 (3)

Wales, 1910) the shorter spicule was reported to be ·047 mm. in length.
ypographical error for ·074 mm.

ckets
s.

O. *fasciata.*
?
·40–·475
·012–·015
·07–·09
·10
2–4 (3)
(·006–·009)
·18–·23
·003

O. *fasciata.*
– – – –
Male not yet known

This

Acknowledgment is made to Mr. N. V. Brown, Brisbane, for his kindness in forwarding material from various parts of Queensland; and to Dr. E. W. Ferguson, Health Department, Sydney, for the loan of some mounted preparations.

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NOTES ON THE GEOLOGY OF THE MOORLANDS (SOUTH AUSTRALIA) BROWN COAL DEPOSITS.

By A. C. BROUGHTON.

[Read October 13, 1921.]

Carbonaceous shales and lignitic material were located in a well sunk by Mr. Turner in the Hundred of Sherlock, about the year 1907, situated about 100 yards east from the Hundred of Seymour and 2,500 yards south from the Hundred of Hooper.

Several attempts were made to determine the extent of the formation, and investigations were carried out with a view to its utilization. It was not until the early part of 1920 that systematic and extensive work was undertaken to thoroughly test the locality. This is now being done by a private company—the Tailem Bend and Murray Coal Company—as well as by the South Australian Government. The results are made the subject of the present notes.

The area is being tested by bores every 300 yards, and where results justify every 150 yards, or closer. By this means very complete geological sections may be obtained. In the case of the company's bores, cores were collected every few inches from the surface to bed rock. The South Australian Department of Mines has a calyx drill working on this area, and the cores obtained by this drill are analysed by the Department. To date (September 18, 1921) the company has sunk 73 bores and the South Australian Government 20.

The following four particular bores will indicate the method of tabulating the records. The first three, *i.e.*, Bores A, B, and C, were sunk by the company. The fourth, D, shows how the coal is analysed, as the figures have been made available by the South Australian Department of Mines. The analyses were made by Mr. W. S. Chapman, of the School of Mines and Industries:—

BORE A.	Thickness. Ft.	Depth from Surface. Ft.
Surface sand	3	3
Travertine limestone	2	5
Pale-green and dull yellow-brown sand ...	3	8
Hard compact limestone	4	12
Pale-green clay, inclined to be arenaceous	1½	13½
Dull-yellow arenaceous clay, pale-green clay, yellow sandstone	2½	16

Bore A.	Thickness. Ft.	Depth from Surface. Ft.
Light-brown and yellow arenaceous clay	3	19
Dull-greenish sands, marine shells, sharks' teeth in this zone	3	22
Pale-yellow and grey and a little greenish arenaceous clay	8	30
Light-brown, grey, yellow, and greenish-yellow arenaceous clay with nodular ironstone, passing into carbonaceous shales of a chocolate colour at bottom	4½	34½
Brick-red and light-brown clay, yellow and grey arenaceous clay	½	35
Dark-grey arenaceous clay with reddish-brown streaks, light- and dark-yellow arenaceous shales, chocolate-coloured arenaceous shales	2½	37½
Interbanded dark bluish-grey to chocolate and dark-brown arenaceous shales, nodular pyrites, black carbonaceous shales ..	17	54½
Hard compact limestone, marine fossils, includes water-worn quartz grains and pyrites	3	57½
Grey to black carbonaceous shales with grey arenaceous shale bands	8	65½
Coal series with subfossil leaves, wood, and resin	33	98½
White talcose rotten slate, bed rock ...	3	101½

Bore B.	Thickness. Ft.	Depth from Surface. Ft.
Surface limestone	6	6
Green and yellow arenaceous clay, apparently yellow clay with thin seams of greenish sand	6	12
Small seam of black carbonaceous shale ...	½	12½
Talcose rotten slate, pink and greyish hue, bed rock	52	64½

Bore C.	Thickness. Ft.	Depth from Surface. Ft.
Surface soil	5	5
Travertine limestone	13	18
Greenish sand	6	24
Yellow clay	4	28
Light-grey and light-brown shales ...	5	33
Darker carbonaceous shales	2	35
Coal series	10	45
Carbonaceous shales	2	47
White talcose material, bed rock ...	5	52

BORE D.

The following analyses are supplied by the courtesy of the South Australian Department of Mines. Analyses by Mr. W. S. Chapman, of the School of Mines and Industries (Government number: No. 11 Bore, Moorlands [11 M.]):—

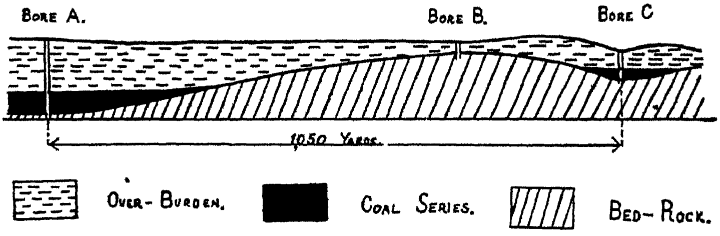
No. of Sample	Description.	Depth from Surface.	Analyses as Raised.			
			Moisture at 105° C. per cent.	Volatile Matter. per cent.	Fixed Carbon. per cent.	Ash. per cent.
1	Lignite	45′ 2″-50′ 8″	57·01	20·55	13·85	8·59
2	,,	50′ 8″-52′ 2″	50·67	21·67	15·26	12·40
3	,,	52′ 2″-55′ 2″	52·99	21·41	15·26	10·34
4	,,	55′ 2″-58′ 2″	52·75	24·00	15·80	7·45
5	,,	58′ 2″-61′ 2″	53·32	19·84	13·89	12·95
6	,,	61′ 2″-62′ 8″	54·00	22·94	13·40	9·66
7	,,	62′ 8″-65′ 8″	49·06	20·68	12·57	17·69
8	,,	65′ 8″-69′-2″	52·48	15·94	8·36	23·22
9	,,	69′ 2″-72′ 2″	48·41	20·09	11·46	20·04
10	Lignite	72′ 2″-74′ 8″	45·65	17·54	9·33	27·48
11	with clay	74′ 8″-75′ 8″	33·16	11·35	5·96	49·53

The first three bores have been chosen for description because they indicate the rapid alteration that occurs over comparatively short distances. The fourth bore has been selected because it is a typical example of the composition of the lignitic or brown coal series.

The Bores A, B, and C are in a straight line, north and south, 1,910 yards east from the boundary between the Hundreds of Sherlock and Seymour. The most northerly of these, *viz.*, Bore A, is about 2,830 yards south from the Hundred of Hooper. The distance between this and Bore B is 750 yards; the distance between Bores B and C is 300 yards. These three together, with Bore D (a Government bore), are representative of 93 bores on the area considered.

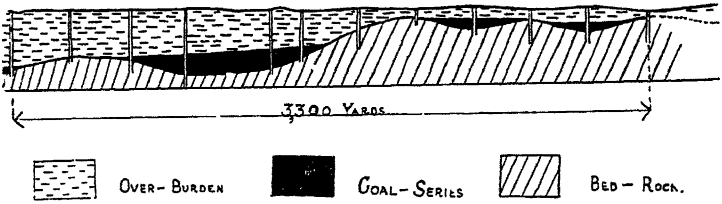
GEOLOGICAL SECTION 1.

Basin formation indicated by Bores. Vertical thickness exaggerated five times. Surface configuration according to Topographical Survey.



Geological Section 2.

Formation indicated by 12 Bores, in line, at 300 yards' interval. One Bore is 150 yards from next closest Bore. Vertical thickness exaggerated nine times. Surface configuration according to Survey.



The following table supplies particulars of Bores A, B, and C in respect to over-burden, thickness of coal series, and depth at which bed rock was struck:—

	Bore A.	Bore B.	Bore C.
Over-burden	67½ ft.	12½ ft.	35 ft.
Coal series	33 ft.	—	10 ft.
Bed rock at	100½ ft.	12½ ft.	45 ft.

From the preceding table it will be seen:—(1) The coal series occur in shallow basins; (2) a rapid variation in the thickness of the coal series; (3) old surface topography determines the coal basin occurrences.

From the log of Bore A, which is typical of 93 other bores over the area, we find that seven distinct lithological characteristics are encountered in regular order from the surface downwards:—

vii. Surface sand and travertine.
vi. Greenish and yellowish clays in which a greenish sand containing sharks' teeth occurs as a distinctive zone. Fossiliferous limestones.
v. Carbonaceous shales.
iv. Hard grey fossiliferous limestone with pyrites and quartz pebbles.
iii. Carbonaceous shales with appreciable amounts of iron sulphides.
ii. Brown coal series.
i. Rotten talcose slates, bed rock.

In places the bores have penetrated for some distance—in one place 52 ft.—into the old rock underlying the formations in which the coal series occur. Generally speaking, this old rock has been found to be a pipe-clay, if overlain by carbonaceous beds of any thickness. If the carbonaceous beds are thin, or absent, and fossiliferous limestones, arenaceous clays, clays, or sandstones immediately rest upon the bed rock, the latter is coloured in a variety of shades, such as delicate pink and silvery-grey, light green to a slate colour, intense purples, dull greens, and reds. The proximity of the carbonaceous deposits has resulted in a bleaching of the adjacent older formations.

Some bores have shown quartz or ironstone to occur in the bed rock immediately beneath the beds in which the coal series are found. When this occurs the quartz and ironstone are generally located near to the surface, indicating that such occurrences, by their greater resistance to weathering, led to elevations in the contour during the time immediately preceding the deposition of the brown coal series. Sometimes, when the quartz and ironstone have been penetrated, large lumps of undecomposed slate have been brought up in the boring tools, suggesting the presence of mineral reefs and lode breccia.

In addition to the bores, a number of shafts have been sunk in the district, several of which have penetrated the coal, and, in two places, considerable underground development gives an opportunity to examine the coal *in situ*. About 700 tons of coal have been raised, the quality of which may be gathered from particulars given of Bore D, which includes an analysis by Mr. Chapman, at the instance of the Mines Department.

Associated with the coal seam are remains of trees, still showing the original cellular structure, some with the original pith, which is grey and soft. The grain of the wood in some of these old trees is so well preserved that the timber may be splintered like deal.

These subfossil trees occur generally in a horizontal position within the enveloping carbonaceous matrix. This matrix contains small globules of a yellow resinous substance, and, occasionally, larger nodules of a darker resin, similar to yacka gum, in shape and colour, and a characteristic fossil leaf showing veination and cellular structure. This bed has the appearance of an old peaty deposit. Masses of the fossil leaves, sometimes $\frac{1}{8}$-in. in thickness, occur. In some places interbedded arenaceo-carbonaceous shales are met with in the coal deposit, indicating a local variation of conditions of deposition.

Conversion of the vegetable remains to a highly bituminous material is often observed; also the complete replacement of the original woody tissue by sulphide of iron, forming a pseudomorph in pyrites and showing the original vegetable structure. The mode of formation of these coal deposits was perhaps similar to the present-day swamps on the adjacent Murray back-waters.

From the evidences available the following order of occurrence may be suggested:—

(1) Denudation of high land immediately preceding a depression of the local area.

(2) Depression of the area which permitted swamps to form, into which were carried and retained timber and other organic material, the *débris* of floods and continental drainage.

(3) The previous dry land (Pre-Cambrian) now became basins in which newer sediments were deposited; the more elevated portions remained as islands or dry margins. Into the swamps, within the basins, highly carbonaceous muds were carried by floods; this, together with vegetation brought by flood waters and swamp plants which grew *in situ*, formed a peaty deposit.

(4) Further subsidence, preceded by local changes, caused deposition of less carbonaceous material with a corresponding increase of mineral sediments forming shales. Such subsidence permitted the sea to encroach and finally cover some, if not all, of the swamp land.

(5) Slight elevation then succeeded, and swamp conditions again eventuated, with the formation of thick carbonaceous shales.

(6) Another subsidence followed and the sea encroached. A series of fluctuations now occurred, evidenced by greenish sands (which contain sharks' teeth), sandstones, marine fossils in limestones, and clays. Finally the whole area was again elevated to dry land and our present-day conditions came into existence.

THE STATUS OF THE DINGO.

By F. Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read October 13, 1921.]

Speculations concerning the origin of the Warrigal, or Dingo, have occupied a considerable place in Australian zoological literature, and if we accept Etheridge's 1916 Memoir as being the latest authoritative pronouncement upon the subject, we are forced to conclude that, in Australia at any rate, the question is regarded as by no means settled.

Etheridge postulates two alternatives: the Dingo may be indigenous, or it may be introduced; but he concludes his essay by saying, "which of the postulates the reader is prepared to adopt must be left to his interpretation of the facts stated." The reader will possibly be left with the impression that the author believes the animal to be indigenous, but the facts embodied in the substance of the paper are hardly sufficient for either author or reader to form a very definite opinion

This uncertainty is, unfortunately, given currency in text-book literature, and Beddard (Mammalia, Camb. Nat. Hist., p. 421) says, "it does not seem certain whether it was tamed and brought over to Australia by the native races, or is a true and indigenous Australian species." It is owing to this apparent uncertainty concerning the animal that the present author has thought it worth while to write a paper upon a subject to the discussion of which he brings forward no new facts and no new theories.

[A] A brief survey of the literature yields the following opinions expressed, from time to time, by authorities upon Australian zoology:—

(1) The Dingo has been claimed to be an indigenous Australian mammal—an animal which originated within the confines of the Australian continent. Prof. McCoy (Prod. Paleont. Vict., Acc. vii., pp. 7-10) remarks that "the Dingo was really one of the most ancient of the indigenous mammals of the country." Again, Gerard Krefft (Mammals of Australia) says, "It must be accepted as a fact that the Dingo is indigenous."

(2) It has been claimed that the Dingo is not only an indigenous Australian mammal, but that it is, actually, the ancestor of the domestic dog. J. Douglas Ogilby (Cat. Aust.

Mamm., p. 125) states, "Until proof to the contrary is forthcoming, we shall consider the honour of being the original progenitor of our domestic favourite as due to the Australian Warrigal."

(3) It has been claimed that the Dingo is a wild, true species of *Canis* which came to Australia, unaided by and unassociated with man, by a land route which has ceased to exist. Lucas and Le Souëf (Animals of Australia, pp. 9-14) assert, "We must conclude that the Dingo reached this continent without the aid of man"; he "wandered into Australia when the land bridge existed where Torres Strait is now." The same view is expressed by Dr. R. L. Jack, who says (Geol. Pal. Q'land, 1892, p. 623), "The Dingo arrived by some chance means of conveyance without assistance, or he may have simply walked overland."

(4) It has been urged that the Dingo is a domesticated dog, which, as the companion of man (in the form of the Australian aboriginal), came to Australia from the north by a land bridge.

(5) It has been argued that the Dingo is a domesticated dog which came in with the Australian aboriginal, not by a land bridge, but by a sea route.

(6) It has been said to "owe its introduction to early Malay settlers from Asia" (Aflalo. Nat. Hist. Austr., p. 6).

(7) The Dingo has been said to be a domesticated dog introduced by Dutch navigators. Mr. J. Neil McGilp (South Australian Naturalist, vol. ii., No. 3, p. 59) states, "Most people, I believe, think that the Dingo was introduced by Dutch navigators into the Northern Territory." How widespread this belief may be I do not know.

[B] The antiquity of the Dingo in Australia has been very variously estimated:—

(1) It has been said to date from the Pliocene. McCoy (*op. cit.*) states, "Our present species, although still living in great numbers, I have no doubt dates from the Pliocene Tertiary time."

(2) It has been claimed as "one of the most ancient of the living Australian land mammals" by Lucas and Le Souëf.

(3) On the other hand, it is said to be no older than the period of the Dutch navigators.

[C] Strangely enough, although it is easy to find speculations concerning the zoological affinities of the Dingo, it is a difficult matter to discover exactly what points authors have relied on for their determinations. So far, I have been unable to trace among the writings of those who have speculated on the status of the Dingo, any indications of precise investigations into the crucial zoological characters of the animal they are dealing with:—

(1) McCoy says, "It was certain that the native dogs of Continental Asia were not clearly related, to the extent of specific identity, with the Australian one, nor could any near analogies be found elsewhere."

(2) Lucas and Le Souëf state that "in the anatomy of his teeth and skeleton he seems to be intermediate between the wild dogs of South America and the dogs and wolves of the Old World." Unfortunately the skeletal and dental characters by which this comparison was arrived at are not stated, and the particular wild dogs of South America, with which the comparison was made, are not specified.

(3) Ogilby pictured it as a wild dog which was the ancestor of all domesticated dogs, and Mr. C. M. Woodford gave it as his opinion that "the Dingo is probably the progenitor of the domestic dog of all the Pacific Islanders."

(4) Beddard assumes a non-committal attitude and calls the Dingo "an interesting and somewhat mysterious species of dog or wolf."

[D] That the Dingo is some sort of a dog is practically the only point upon which all writers have agreed. But it is one thing to agree that the Dingo is a dog, and another to agree as to what, zoologically speaking, a dog is. Before precise anatomical points were studied as the criteria for specific distinctions, a vast amount of speculative literature was woven about the problem of the origin of the dog as a domesticated animal. In Darwin's Animals and Plants under Domestication (1868) will be found a very good account of the opinions that had been put forward up to the time of writing this great work. It had been claimed that the domestic dog had his origin in the jackal, in the wolf, or in some species no longer extant. It had been claimed that the domesticated races were polyphyletic—that some had arisen from one wild stock and some from another. It had been claimed also that the origin was a mixed one, and that domestic dogs had arisen by the crossing of various wild stocks living or extinct. This uncertainty still exists in most accounts of the origin of the dog; even our best text-books still hesitate concerning the wild progenitor of the domestic dogs, and most seek safety in hints at polyphyletism. Most of the uncertainty that prevails is due to emphasis laid upon such variable characters as coat colour, and texture, tail and ear carriage, and such other external and conspicuous but highly plastic features. Again, the relative fertility of domestic races with local feral races, or true wild species, has confused the issue.

In the genus *Canis*, as it is at present constituted, there are two main types—the true wolves and the jackalls. These two main types differ from all the other animals, formerly included in the genus, in two intrinsic anatomical features: (1) the pupil of the eye is circular when contracted, and (2) in the skull, the supra-orbital region and processes are inflated and convex. In these features the true members of the restricted genus *Canis* (which is practically the Thooid or Lupine series of Huxley) differ from the Alopecoids or Vulpine series, which have the pupil of the eye elliptical, and the supra-orbital region and process uninflated and concave.

All dogs, domestic or feral, conform to the first type and therefore belong to the restricted genus *Canis* or to the Thooids of Huxley.

Within the restricted genus *Canis*, the members have a full cynoid dentition, and in this they differ from the wild dogs of south-eastern Asia (the most probable immigrants in a "walk overland" colonization) which possess a dentition reduced by the loss of the last lower molar, and are separated into the genus *Cyño*. All domestic and feral dogs possess the full dentition, and therefore are not to be considered as descendants of the wild dogs of south-eastern Asia. The true wolves of the northern parts of the Old and New Worlds, and the jackals of southern Europe, Asia, and Africa, are, therefore, left as the possible progenitors of the domestic and feral races of dogs. The northern wolves differ from the jackals in (among other things) the form of their first upper molar tooth. In the jackals this tooth has a platform—the cingulum—running around the outer (labial) side of the crown; in the wolves the platform is reduced or wanting in the middle of its length. This condition of reduction of the cingulum must be regarded as a specialization in the northern wolves, since a complete cingulum is present in *Alopex*, *Vulpes*, and other Cynoids.

What is the condition of the cingulum of the first upper molar tooth in the feral or domesticated dog?—a Cynoid animal which has the full canine dentition, a circular pupil, and an inflated and convex supra-orbital process. Is the cingulum of the generalized Cynoid type, or is it the specialized and reduced type seen only in the true northern wolves? In every breed of domestic dog that has been examined, the specialized wolf tooth, and not the primitive jackal tooth, has been present. Mr. Gerrit Miller, of the United States National Museum, has given especial attention to this point and has declared the northern wolf origin of all races of domestic dogs (see Catalogue of the Mammals of

Western Europe). Again, in the American Journal of Mammalogy (Vol. I., No. 3, May, 1920, p. 149), Mr. Miller states, "In all specimens (of domestic dogs) that I have examined, representing very diversified breeds, the skull and teeth remain fundamentally true to the type which in wild canids is peculiar to the northern wolves. This type, particularly as regards the cheek teeth, does not represent a primitive condition which might be expected to occur in various members of the family without having any special significance. On the contrary, in respect to the development of a combined cutting and crushing type of carnassials and molars it is the most highly specialized type now in existence."

The domestic dogs are, therefore, monophyletic in so far as all are the descendants of the northern wolves; but, as Mr. Miller points out, domestic dogs will breed back with wolves, "and by this process many, possibly all, local forms of the wolf have perhaps contributed to the peculiarities of the domestic races." In other words, the domestic dogs may be claimed as polyphyletic in so far as various local races of northern wolves may have contributed to their ancestry; but monophyletic in so far as nothing but northern wolf has gone to their making.

The examination of a series of Dingo skulls can leave no doubt as to the true affinities of the Australian animal. The Dingo falls into line with all the other races of domestic dogs in being of the true northern wolf type. Moreover, in the large size of the carnassial teeth he approaches nearer to the ancestral type than do the other races of dogs of which I can obtain specimens or records.

The following table (Table I.) shows the basi-condylar length of the skull, and the length of the upper carnassial tooth, in a series of 22 genuine Dingo skulls. For permission to examine 20 of these specimens I am indebted to the authorities of the South Australian Museum (measurements are in millimetres):—

TABLE I.

No. and source of specimen.	Basi-condylar length.	Upper carnassial length.
1. S.A. Mus.	165	19·5
2. S.A. Mus.	165	20
3. S.A. Mus.	167	19
4. S.A. Mus.	169	21·5
5. S.A. Mus.	170	18
6. S.A. Mus., reared in captivity, ♀	170	16
7. S.A. Mus.	171	21
8. S.A. Mus.	174	19·5
9. S.A. Mus.	175	21
10. S.A. Mus.	176	20
11. F. W. J.	177	20

No. and source of specimen.	Basi-condylar length.	Upper carnassial length.
12. S.A. Mus.	178	20
13. S.A. Mus.	179	20·5
14. S.A. Mus.	180	21
15. S.A. Mus.	180	20
16. S.A. Mus.	181	21
17. F. W. J.	182	21
18. S.A. Mus.	184	20·5
19. S.A. Mus., reared in captivity, ♂	185	19
20. S.A. Mus.	190	20·5
21. S.A. Mus.	190	21
22. S.A. Mus.	193	22

The average of the measurements in this series shows that the Dingo, as a breed, has a basi-condylar length of 177·3 mm. and an upper carnassial length of 20 mm.

Table II. shows corresponding measurements of a series of domestic dog skulls, some of the figures being taken from the published records, and some from specimens in the South Australian Museum:—

TABLE II.

Breed of domestic dog.	Basi-condylar length.	Upper carnassial length.
1. Great Dane (Winge)	255	22
2. St. Bernard, S.A. Mus.	248	20
3. Large dog (Miller)	230	21·6
4. Mastiff, S.A. Mus.	230	22
5. St. Bernard. S.A. Mus.	228	22
6. Dog of the Iron Age from Denmark (Winge)	209	20
7. Average of 10 large dogs (Miller)	200+	20·5
8. Greyhound, S.A. Mus.	195	18
9. Greyhound, S.A. Mus.	185	17
10. Average of 20 Dingos (F. W. J.)	177·3	20
11. Chow dog, S.A. Mus.	170	17

It will be noticed from these tables that the Dingo, as a type, is a dog which possesses very large teeth, for the small-headed Dingo may have a condylo-basal length of only 165 mm. (No. 2, Table I.), and yet possess an upper carnassial tooth as large as that of a St. Bernard, the condylobasal length of whose skull is as great as 248 mm. (No. 2, Table II.). It may be mentioned that the two greyhound skulls, in the South Australian Museum series, were mixed in with the 20 Dingo skulls, and although their measurements do not appear strikingly different from those of the Dingos, nevertheless, their relatively small teeth enabled them to be picked out with certainty before any measurements were taken. Of the very small series of dog skulls which I have been able to examine the Chow dog shows the greatest likeness to the Dingo in the form and proportions of the upper carnassial teeth. But large though the carnassials are in the Dingo, they do not reach the proportions of the same teeth in the wild northern wolves, for the average for the wolf tooth is 26 mm.; yet it must be remembered that the wolf skull is a large one, the condylo-basal length being constantly more than 200 mm.

It may be a mere coincidence that the two Dingos which were reared in captivity (Nos. 6 and 19, in Table I.) happen to have developed relatively smaller teeth than is normal in the race; nevertheless, the fact is suggestive of the manner in which the tooth reduction has come about in the more pampered races of the domestic dog.

It may, I think, be taken as certain that the Dingo is a domesticated and feral descendant of the true northern wolf, and that among such descendants he shows a primitive retention of his ancestors' great teeth. Physiologically, he has inherited the comparatively inoffensive smell of the wolf, and the habit of silent hunting; and in both these characters he differs widely from the jackals, the only other members of the restricted genus *Canis*. Evidence that the Dingo is a true domestic dog is to be found in the variability of his coat colour. Although it is commonly said that a pure-bred Dingo is difficult to find nowadays, proof of this statement must not be deduced from the fact that wild dogs of very varying colour are met with, for, as Mivart has pointed out, the first white men who came in contact with the Dingo remarked that both black dogs and red ones were common.

[E] Having dealt with the zoological affinities of the Dingo, a more certain basis is provided for discussing the opinions that have been put forward as to the status of the animal in the Australian mammalian fauna:—

(1) The supposition that the Dingo is indigenous, *i.e.*, that its phylogenetic story was unfolded within the confines of Australia, is absolutely untenable, and should, once and for all, be dismissed from literature having any pretence to scientific accuracy.

How the evolution of a Monodelphian Cynoid could have been accomplished in the absence of any possible ancestral forms, is a point which the advocates of the indigenous origin of the Dingo should be called upon to explain. The evolution of a modified northern wolf in an isolated portion of the Southern Hemisphere, tenanted solely by Ornithodelphians, Didelphians, and a few stray Monodelphian rodents and bats, is a thing which is zoologically inconceivable.

(2) The doctrine that the Dingo is "one of the most ancient of the living Australian land mammals," enunciated

by Lucas and LeSouëf, is ridiculous. In a land where *Ornithorhynchus* and *Myrmecobius* survive, the presence of a feral descendant of an introduced, domesticated northern wolf can merely be regarded as a relatively recent intrusion.

(3) The theory that the Dingo, as such, is the ancestor of all domesticated dogs, is absurd, and even that it was the ancestor of the dogs of the Pacific Islanders is difficult to credit. How did the Dingo spread its progeny about the world? If the introduction of the dog into Australia is a problem, what then of the infinitely greater difficulty involved in the dispersal of its progeny from Australia to the rest of the world, or even only to the Pacific Islands? A great deal of ingenuity must be expended in the planning of land bridges before the thesis can be considered as anything more than a mere random assertion.

(4) The claim that the Dingo is so ancient an inhabitant of Australia that he must have come before the earliest human arrival set foot here, must be considered from two points of view: first, the antiquity of man in Australia; and second, the possibility of the Dingo's unaided entry. Our knowledge of man's long tenure of the continent of Australia has been considerably enlarged by the finding of the Talgai skull, for though it must be admitted that "no absolutely certain evidence exists as to the exact level at which the skull was located" (Dr. S. A. Smith), the intrinsic evidence of its high antiquity is well established.

When taken in conjunction with the human molar from the breccia of the Wellington Caves, reported by Etheridge, the portions of human skeletons discovered under similar circumstances by Krefft, and the evidence collected by Dr. Fenner (South Australian Naturalist, *loc. cit.)*, we need not fear that the high antiquity of the Dingo in Australia need dissociate his advent from that of his human companion. It is safe to say that man and the Dingo were the contemporaries of some of the extinct marsupials, even if we do not venture to assign any geological name to the period of their overlap.

When we come to inquire into the possibility of the Dingo arriving in Australia unassisted by, and unassociated with, man, and when we examine the statements of those who have urged this possibility, we are forced to own that the difficulties of the problem have not always been appreciated by those who have advocated this solution. The easy assumption that the dog "simply walked overland," or that "he wandered into Australia" by a land bridge, has been a pitfall which many have failed to avoid. It need not be urged that the making of land bridges to admit individual members of an insular fauna, though a tempting business, is an extremely risky one. Above all, it is necessary in postulating a land bridge to picture one that would be effective in the admission of the species in question. For a zoologist to account for the admission of the Dingo by a former land bridge, "where Torres Strait is now," is remarkable. It is little use to make a passage from New Guinea to Australia unless a previous series of land bridges connecting New Guinea to the western Austro-Malayan islands is presupposed, and, finally, land bridges to connect the Austro-Malayan and the Indo-Malayan islands. In other words, Wallace's line must first be bridged for the benefit of the descendants of the northern wolves, and then a convenient series of land bridges must be provided for the journey, *via* the Austro-Malayan islands, into the island-continent of Australia. Despite the utter improbability of this thesis of recent land bridges for the admission of the Dingo, they have gained wide currency in Australian literature, and are urged, not only to account for the dog, but even for the admission of the aboriginal (see Howitt, etc.). How great would have been the faunal upset in Australia had land connections with the Asiatic continental masses (and nothing short of this will suffice) existed into the human period, is easy to picture, and may be imagined from a study of the very similar conditions existing in the Panama region. No land bridge that could have admitted either the Dingo or man, separately or in company, could have failed to be the high road of entry of a host of the higher placental mammals from the northern land masses. The fact that the Dingo failed to enter Tasmania, and that even Kangaroo Island was beyond his reach, should be remembered by those who do not fear to make southern land bridges within the period of the human occupation of Australia.

With Gerrit Miller's statement, that "dogs were originally domesticated somewhere within the northern area, inhabited by the true *Canis*, and that they were subsequently taken by man to most of the regions into which they have penetrated," it is impossible, in the face of all the available evidence, to disagree. The Dingo, I imagine, to be no exception to this rule. Just as man carried domesticated dogs to the Pacific Islands, where no indigenous member of the genus *Canis* exists, or has ever existed, so he carried him to Australia. And to Australia, as to the Pacific Islands, he carried him by a sea route. Some years ago, in a lecture delivered in London, I expressed the opinion that "the progenitor of the Talgai man came with his wife, he came with his dog, and with his dog's wife, and he must have done the journey in a seaworthy boat capable of traversing this unquiet portion of the ocean with his considerable cargo. Besides this living freight, and the food and water necessary for the adventure, he carried other things—he carried a knowledge of the boomerang, of the basis of a totem system, and various other cultural features, all bearing a strange suggestion of very distinctly western origin."

This statement has been regarded by some critics as being over-confident; but the examination of the cranial characters of the Dingo, and the comparison of his dental features with those of other Cynoids induces me to repeat it with added confidence.

Since the Dingo is a descendant of the northern wolves, and ranks merely as a variety of domesticated or feral dog, the name *Canis dingo*, given to the animal by Blumenbach, in 1878, cannot zoologically apply; and Australia's feral dog should be known as *Canis familiaris dingo*.

NOTES ON THE GYNOSTEMIUM IN THE GENUS *DIURIS*, AND ON THE POLLINARY MECHANISM IN *PHAJUS*.

By R. S. Rogers, M.A., M.D.

[Read October 13, 1921.]

Plate XXII.

I. On the Gynostemium of the Genus Diuris.

The genus *Diuris* is peculiarly Australian, and does not extend to New Zealand or to any of the adjacent islands.

Its gynostemium is interesting, and apparently marks an important and rather primitive stage in the evolution of the Orchidaceae. The column or essential organ of the Order, in its generally accepted sense, can hardly be said to exist, as the male and female elements arise separately from the receptacle of the flower, and only enjoy a brief and adventitious union during the short period of maturity.

The anther is attached to a short filament, which arises from the posterior margin of the receptacle. It is placed vertically, and is considerably longer than the filament that bears it. It is 2-celled, each cell containing a bilobed pointed or pear-shaped pollen-mass, the pollen of which is mealy. The lines of dehiscence are vertical, and when ultimately the integuments split and retract, they leave two cusps below in which the bases of the pollinia are supported. There is no clinandrium.

Up to this point, anther and pollinia together form an entity, entirely separate from other portions of the sexual apparatus.

The stigmatic-plate carries the stigma and the rostellum on the upper part of its anterior face, and it is contracted below into a style which takes its origin in front of, but at a lower level than the filament of the anther, to which at this stage it has no sort of attachment whatever. The style is situated immediately over the cavity of the ovary, with which it communicates by means of the stigmatic-canal. The stigmatic-plate, or pistil, is approximately about the same height as the anther and, like it, is quite erect. The "disc" is at first an integral part of the rostellum, but as functional activity approaches, separation-cells are seen to be forming around it, necrosis takes place, and it is left lying loose in a slot in the apex of the rostellum.

The stigmatic-plate and the organs which it carries stand immediately in front of the anther with its bulging pollen-cells, but so far there is no connection between the two elements.

The filament of the anther is winged and the wings are produced vertically upwards into two linear structures of varying shape, which bridge the space between anther and stigma, and protect the pollinia after dehiscence against displacement and the drying influence of the air.

Dehiscence is now about to take place, and the rostellar-disc begins to secrete freely. The anther is rigidly supported behind by the fleshy curved base of the dorsal sepal. In front and at the sides, the whole of the sexual apparatus is embraced by the still erect labellum and its lateral lobes; the raised line or lines at the base of the lamina are exerting an increasing pressure against the stigmatic-plate in their progressive development, thus forcing the sexual elements of the flower more closely together. Dehiscence occurs, and for the first time union is established between the male and female elements of the plant The apices of the pollinia become adherent to the back of the rostellar-disc. There is no caudicle. The flower expands; the insect-visitor removes the "viscid disc" together with the attached pollinia, and cross-pollination is then effected in the usual manner

It is interesting in this connection to examine the gynostemium of *Prasophyllum*, which has reached a higher degree of specialization than that of *Diuris*. Here the filament of the anther is still retained, but it has become adnate to the base of the style, so as to form a very short column. The wings of the filament are very similar to those in *Diuris*, but in most members of the genus they have become adnate to the sides of the stigmatic-plate, so as to still further consolidate the column. The pollinia are composed of sectile pollen, and they form an attachment to the "viscid disc," not directly as in the case of *Diuris*, but through the intervention of a well-marked caudicle. The structure of the column is most easily studied in *P. elatum*, in which the flowers are relatively large. In this species the wings of the anther-filament have not yet become adnate to the stigmatic-plate.

Prasophyllum is almost exclusively an Australian genus, its only extension of range being to New Zealand.

These two genera do not appear to have developed along the usually accepted lines of evolution, which are presumably as follows:—

1. Suppression of some of the sexual parts and confluence of the rest to form a column
2. Aggregation of the pollen into pollen-masses.
3. Formation of a rostellum.

4. Appearance of a "viscid disc" on the rostellum.
5. Development of a caudicle or its equivalent.
6. Conversion of the pollinia from mealy or granular into waxy masses.

Both are in possession of some of the more recently acquired characters of the Order, whereas in the one the column has not yet developed, and in the other it is apparently still in an early stage of evolution.

II. On the Pollinary Mechanism of Phajus.

Two species of *Phajus* indigenous to Queensland have been accepted as valid by the late R D. Fitzgerald, F. M. Bailey, and other botanists.

Fitzgerald, indeed, prepared a beautiful plate of each of these, but did not live to complete the letter-press; consequently many important points connected with the pollinary mechanism have been left in doubt. Recently the writer has been fortunate enough to receive from Mr. C. T. White, Director of the Brisbane Botanic Gardens, a quantity of material which enables him to supply many details in regard to these Australian species which have hitherto been obscure or uncertain.

In the case of *P. grandifolius*, Lour., the material available has been ample, and has represented satisfactorily the various stages of development of the column in that species. The earliest stages were scantily represented in *P. Bernaysii*, Rowl., but the material is believed to have been sufficient on which to base trustworthy conclusions.

1. **P. grandifolius,** Lour. The structure of the column at maturity is shown in Fitzgerald's illustration. The upper part is dilated with fleshy wings. The anther is lid-like; it is attached just above the clinandrium and is situated horizontally over the stigmatic-cavity. The latter is, to a very considerable extent, shut off by the upward growth of its anterior margin, and by the inward encroachment of the lateral ones which are produced into two triangular inturned appendages. The appendages are continuous with the upper border of the stigma which is immediately below the clinandrium. There is no rostellum and no disc, so that the clinandrium, which is exceedingly shallow and oblique, merges almost insensibly into the stigma.

The stigmatic-cavity is capacious and its lower part is in free communication with the stigmatic-canal. Its surface begins to function very early and secretes copiously even before dehiscence of the anther.

In the early stage of development, the anther is placed perfectly upright on the apex of the column with its two large parallel cells bulging anteriorly. There is as yet no marginal growth to the stigma, and its surface, which is already viscid, is fully exposed as a rounded depression on the face of the column. Its appendages show as a blue dot on each side at the base of the anther-cells.

As development proceeds, the anther begins to descend and it gradually assumes an oblique position; the margins of the stigma grow upwards and inwards, so as to more readily accommodate the abundant secretion; the entrance to the stigmatic-cavity is further constricted by the growth of the appendages, whose function it is to limit the downward progress of the anther.

Dehiscence takes place in the early bud, when the anther has been brought to rest in the horizontal position by contact with the stigmatic appendages. Internally the anther is divided into two complete or primary cells, each of which is subdivided into two incomplete chambers. The four cells contain eight pollinia, arranged in an upper and a lower series of two pairs each. The former is accommodated in the upper part of the anther-cap, the points of the masses converging towards the apex of the anther and their bodies disposed radially towards the circumference. The second series, which is somewhat larger than the first, is situated immediately below, but considerably to the rear of the upper ones and overlapping their bases. Their covering membranes bulge considerably below the rim of the anther-cap.

The masses appear to be more or less embedded in a yellow granular matrix of a flocculent filamentous nature. This material is most abundant towards the apices, but it is also to be observed between the bodies of the masses as well as between the pollinia and the various septa. A careful examination of the anther before dehiscence shows that the matrix has become consolidated into linear bands or caudicles connecting together the apices of each upper and lower pair of pollinia in the dichotomous manner so beautifully illustrated by Francis Bauer,(1) more than a century ago, in Bletia Tankervilliae. These caudicles are of an unstable and fragile nature, and become broken up or pulverised after dehiscence, or even before, consequently they are only to be seen and dissected out in the early bud. Each pollen-mass is somewhat rounded or ovate with a short acute apex, and is also plano-convex, the plane surfaces of each pair being in apposition.

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(1) Illustrations of Orchidaceous Plants, Tab. 1.

When dehiscence occurs, the covering membranes retract widely; the pollinia of the lower series are brought into contact with the stigmatic fluid, and seepage begins to take place, particularly into the two external masses. So rapidly do these latter become affected, that they rarely change their position and become quickly amalgamated with the viscid contents of the stigma The inner pair usually slip down at the apices which are commonly to be seen protruding round the inner margins of the stigmatic appendages Members of the upper series are subsequently liberated by retraction of the interlocular septa. The pollinia soon become cheesy under the influence of the stigmatic fluid and are then converted into a glutinous mass Innumerable pollen-tubes are developed and may be traced as a mucoid cord down the stigmatic canal to the ovary.

Self-pollination therefore takes place in the bud, and it is inevitable that every flower should become fertilized, unless some untoward circumstance should interfere with the descent of the anther.

The only service conferred upon the plant by the expansion of the flower would appear to be the rapid drying up of the stigmatic contents and the effectual sealing of the stigmatic-canal. After expansion, the remains of the four lower masses are still to be traced as four rather dense elastic caruncles adhering to the back of the stigma.

2. **P. Bernaysii,** Rowl. This species bears a large and handsome yellow flower. Structurally the column approaches closely to that of *P. grandifolius,* but whereas the opening into the stigmatic cavity of the latter is V-shaped, in *P. Bernaysii* it is quadrilateral in form and very much smaller. The chief difference, however, is to be found in the attachment of the pollinia, which are approximately of the same size in both series so long as they are uninfluenced by the stigmatic fluid. A careful examination of the material available failed to disclose any evidence of attachment by dichotomous caudicle, even at an early stage of bud development. It was noted that at the apices of the masses, the granular material occasionally assumed a loose linear formation remotely resembling a caudicle, but in no instance did there appear to be a dichotomous connection between the individuals of a pair and between the corresponding pairs of two series, such as was found to exist in *P. grandifolius* Dehiscence takes place very early in the bud, but pollinia are often retained, longer than would be expected from the frail nature of their attachment, some generally being found *in situ* after expansion of the flower. They also retain their

consistency and do not become agglutinated so rapidly as in the other species. As in the latter, the external members of the lower series are the first to become softened by absorption of stigmatic fluid, the others usually remaining uninfluenced and retaining their form until they are released from the matrix and fall into the stigmatic-cavity.

The tendency in the genus *Phajus* to produce supplementary anthers or staminodia is well known. Three such cases were observed in the material under examination. The staminodes took their origin from the upper shoulder of the wing and represent the suppressed lateral anthers of the inner whorl.

EXPLANATION OF PLATE XXII.

Fig. 1. Column of *P. Bernaysii* from the front, the anther is in the horizontal position; dehiscence has taken place. *a*, anther; *st*, stigma, *ap*, stigmatic appendage; *w*, wing of column; w_1, origin of staminode: *p*, pollen-mass of 2nd series showing below rim of anther.

Fig. 2. The anther has been removed together with the upper series of pollinia. Two pairs of pollinia belonging to the lower series can be seen, their bases still resting in the clinandrium. Lettering as in fig. 1, with the addition of: a_1, point of attachment of anther to back of column.

Fig. 3. A vertical mesial section of column, anther and pollinia removed; lettering as before with the addition of: *st.c*, stigmatic-canal; *cl*, clinandrium.

Fig. 4. Anther from below showing the two pairs of pollinia of the upper series. One pair is detached, showing the convex and plane surfaces of the masses and their acute apices. Lettering as in fig. 1, with the addition of: p_1, pollen-mass, showing convex surface; p_2, pollen-mass showing plane surface; *i*, retracted integuments.

Fig. 5. A vertical section through the upper part of column, the anther and upper series of pollinia removed. Dehiscence has taken place and a pair of pollinia belonging to the lower series may be seen with their bases resting in the clinandrium, their apices having slipped down against the margin of the stigmatic appendage. Lettering as in the preceding figures.

Fig. 6. Gynostemium of *Diuris longifolia* from the front showing: *ap*, anther-point; *w*, wing of anther-filament; *st*, stigma; *rd*, rostellar-disc.

Fig. 7. Same from the back. Lettering as in preceding figure, with addition of: *a*, anther.

Fig. 8. Same from the side, showing separate origins from the receptacle of anther-filament and the style of the stigmatic-plate. The wings of the filament have been removed. *a*, anther; *ap*, anther-point; f_1, anther-filament; f_2, style of the stigmatic-plate; *st*, stigma; *r*, rostellum; *p*, pollinia.

Fig. 9. Stigmatic-plate from behind with pollinia attached to viscid disc of rostellum. The anther and its wings have been removed. *st.p*, stigmatic-plate; *r*, rostellum; *p*, pollinia.

THE WING-VENATION OF THE LEPTOPERLIDAE (ORDER PERLARIA), WITH DESCRIPTION OF A NEW SPECIES OF THE GENUS *DINOTOPERLA*, FROM AUSTRALIA.

By R. J TILLYARD, M.A., Sc.D. (Cantab), D.Sc. (Sydney), C.M.Z.S., F.L.S., F.E.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

(Communicated by A. M. Lea.)

[Read October 13, 1921.]

The Leptoperlidae are the dominant family in the Stone-fly Fauna of the Southern Hemisphere, numerous species occurring in South America, New Zealand, Tasmania, and Australia. Owing to the fact that they are inert insects, seldom seen flying, and also because most of the species appear in the winter, or early spring, in Australia, very little is known about them here; and it is curious to note that only a single species, *Paranotoperla australica*, End., from south-western Australia, has, so far, been described from the mainland. They are, however, common on all fast mountain streams, and especially abundant in Victoria and Tasmania; while, even in so warm a climate as that of Sydney, at least two species can be taken fairly commonly from July to October.

In a recent paper ("Canadian Entomologist," 1921, pp. 39, 40) I have tabulated the characters of the various families of the Order Perlaria, and have also given a dichotomic key to the same. The Leptoperlidae may be briefly defined as follows:—

Small to medium-sized stone-flies of a somewhat generalized structure, the mandibles, clypeus, and labrum normal, the palpi with short segments, the anterior coxae placed widely apart, the tarsi with segment 2 shortest, 3 longer than 1, the cerci usually long to moderately long, never reduced to 5 segments or less. In the forewing, Rs is usually either simple or once forked, very rarely three-branched; Cu_1 is simple or forked; 1A is simple; 2A is generally forked, rarely simple.(1) There is no anastomosis or transverse chord in either wing, but the distal half of the forewing, and frequently also of the hind, carries more or less numerous and irregularly placed cross-veins. A complete series of intercubital cross-veins is present in the forewing, together with either a complete or incomplete series of medio-cubitals. In the hindwing, the anal fan is devoid of cross-veins, and there is always either a complete or incomplete fusion of the posterior branch of M with Cu_1, the basal piece of M_3+_4 descending transversely on to Cu_1 and appearing like a cross-vein. In the hindwing also, Rs and M are fused basally for some distance, as in most Perlaria.

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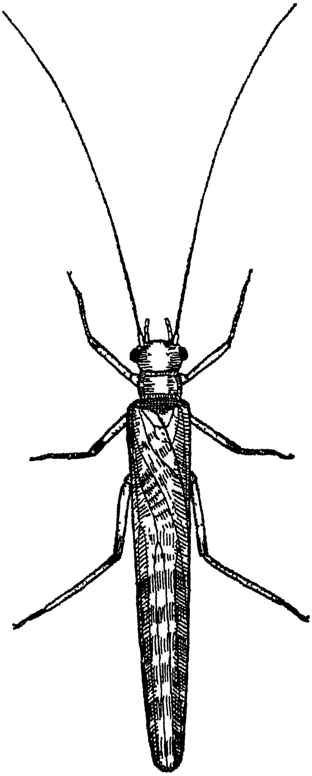
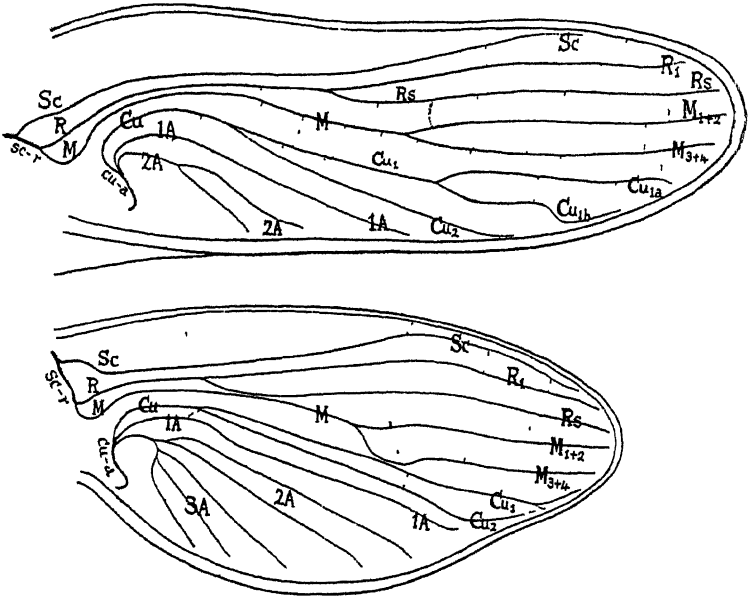
(1) It is possible that these veins are 2A and 3A respectively, and that both trachea and vein 1A have disappeared.

The Leptoperlidae are all slenderly-built insects. In the position of rest, the wings are rolled round the body, the left forewing overlying the right. The larvae, none of which have so far been described, cling to rocks in running streams, and are remarkable for possessing a unique development of a rosette of gill-filaments around the anus, numbering fifty or more, which can be extruded or withdrawn as required. These gills are usually of a beautiful pink or lavender colour, more rarely whitish.



Text-fig. 1.
Dinotoperla carpenteri, n. sp. (×8).
The insect in the natural position of rest.

No study has yet been made of the tracheation of the larval wing in this family. While I was living at Hornsby, New South Wales, I discovered a small Leptoperlid larva on the rocks in one of the creeks flowing into Old Man's Valley, and succeeded in rearing the insect, which was found to be a new species of *Dinotoperla*, and will be described in this paper. A study of the wing-tracheation of this larva led to the discovery of the presence of the important specialization mentioned above for the hindwing, *viz.*, that there is always either a complete or partial fusion of M_3+_4 with Cu_1. The chief purpose of this short paper is to demonstrate this point, as a preliminary to the complete working out of the numerous undescribed genera and species of this family which exist in Australia, Tasmania, and New Zealand, and of which I possess a very large collection.



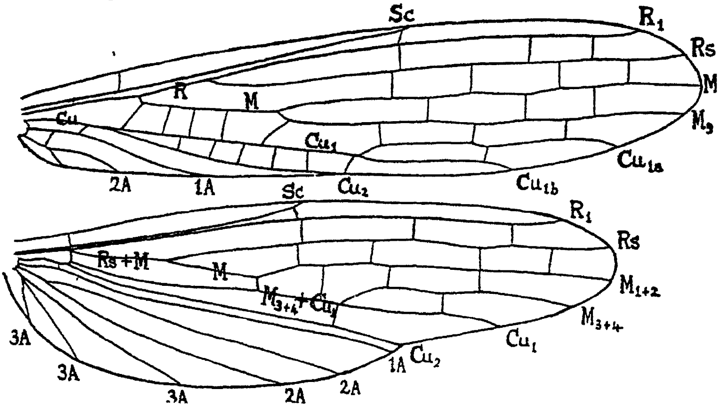
Text-fig. 2.

Dinotoperla carpenteri, n. sp. Tracheation of wings of last larval instar (×48). For lettering, see text-fig. 3, except *cu-a*, cubito-anal, and *sc-r*, subcosto-radial trunk trachea.

Text-fig. 2 shows the tracheation of the wings in the last larval instar of the Hornsby species, *Dinotoperla carpenteri*, n. sp. By comparing this with the imaginal wing-venation, shown in text-fig. 3, the manner of fusion of M_3+_4 with Cu_1 will be clearly seen. In the larval wing, trachea M_3+_4 comes off obliquely downwards from the main stem of M, runs alongside trachea Cu_1 for a short distance, and then diverges from it again, running freely to the wing margin. In the imaginal hindwing, the free basal piece of M_3+_4 takes on the appearance of a cross-vein descending on to Cu_1 at right angles, and, consequently, the free distal portion of M_3+_4, after its fusion with Cu_1, appears as if it were a true branch of this latter vein It would, indeed, be impossible to guess the true condition of these veins without a reference to the precedent tracheation of the larval wing.

The only other genera of Leptoperlidae, so far described from Australia and Tasmania, are *Leptoperla*, Newm., and

Paranotoperla, End. In both of these, M_3+_4, after junctioning with Cu_1, remains fused with its right to the wing margin. The three known genera may be easily separated by the following Key:—



Text-fig. 3.

Dinotoperla carpenteri, n. sp. Wing-venation (×10). 1A, 2A, 3A, the three anal veins; Cu, cubitus; Cu_1, first branch of cubitus, branching, in forewing only, into Cu_{1a} and Cu_{1b}; Cu_2, second branch of cubitus; M, media, branching in both wings into M_1+_2 and M_3+_1, the latter fusing partially with Cu_1 in hindwing only; R, radius; R_1, its main stem; Rs, radial sector, unbranched in both wings; Sc, subcosta.

(1) Cerci longer than abdomen; Rs in forewing, with a long fork ... ... *Leptoperla,* Newm.
Cerci shorter than abdomen; Rs. in forewing simple 2
(2) Cu_1 in forewing, simple; in hindwing, a complète fusion between M_3+_4 and Cu_1 *Paranotoperla,* End.
Cu_1 in forewing, forked; in hindwing, the fusion between the M_3+_1 and Cu_1 is incomplete ... ... *Dinotoperla*, Till.

Genus DINOTOPERLA, Till.

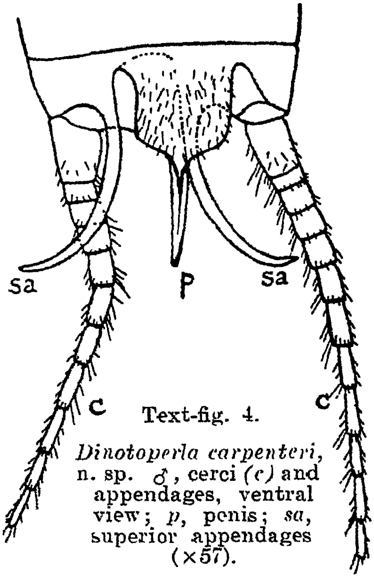
"Canadian Entomologist," 1921, p. 43, text-fig. 4*b*.

DINOTOPERLA CARPENTERI, n. sp.

Text-figs. 1, 3, 4.

Forewing, 10 mm. *Expanse,* 21·5 mm.

Head, thorax, and abdomen dull blackish, touched with dark brown behind the eyes and on notum. *Eyes* brownish-black. *Antennae* about as long as forewing, very slender, with about 50 segments, the basal one slightly enlarged. *Pronotum* rectangular, broader than long. *Legs* dull brownish, the apices of the femora and tibiae darkened; the tarsi darker, except at base of first segment. *Cerci* rather short, 10- to 11-segmented, tapering, delicately haired, the basal segment thickest and much longer than any of the next few succeeding segments. In the male, the *superior appendages* are slender, elongated, curved processes, projecting on either side of the penis, the basal portion of which is a broad plate, the distal portion slender and upcurved. The cerci and appendages of the male are figured in ventral view in text-fig. 4. In the female, the ventral plate is deeply bifid, a deep triangular median notch dividing it into two triangular pieces.



Text-fig. 4.

Dinotoperla carpenteri, n. sp. ♂, cerci (*c*) and appendages, ventral view; *p*, penis; *sa*, superior appendages (×57).

Wings: — *Forewing* medium fuscous, with irregular paler subhyaline spaces between the cross-veins; *i.e.*, each cross-vein is surrounded by a rectangle of the fuscous ground-colour, and the spaces between these rectangles are paler. As the positions and number of these cross-veins is inconstant, varying for each individual, the pattern thus produced is very irregular, and is never very conspicuous. *Hindwing* a uniform medium fuscous. When at rest, the dark and pale areas of the two wings appear to reinforce one another, giving the insect a distinctly banded appearance, as shown in text-fig. 1.

Dedicated to F. W. Carpenter, M.A., late science master at Sydney Grammar School, in memory of many happy days spent in the field together studying aquatic insects.

Locality:—Hornsby, near Sydney, N.S.W. Bred from larvae found on rocks in a small stream in Old Man's Valley; also found sitting about on the stems of reeds and grass near the stream. July to October.

Types:—Holotype (Hornsby, Sept. 14, 1917, R. J. T.) and series of para-types in Tillyard Collection, Cawthron Institute, Nelson, N.Z.

The set specimens have the abdomens so shrivelled that it is impossible to determine the sex or study the sexual appendages. The descriptions of these organs given above were made from slides prepared from specimens of the para-type series.

MISCELLANEA.

Obituary Notices.

REMARKS BY THE PRESIDENT.

During the month one has passed away who, for a quarter of a century was an active Fellow of our Society, Mr. A. H. C. Zietz. He was elected in 1886. As one of the officers in the Adelaide Museum he had opportunities for study of much of our South Australian fauna, both land and marine. His first paper, read in April, 1887, was entitled "Descriptions of New Species of South Australian Crustaceans." He created a new genus for one *Gryllopagurus* and specified the type as *lithodomus*. It was discovered in Gulf St. Vincent by a born naturalist, a young public school teacher named G. W. McDougall, who unfortunately died early in life. Doubtless some of the Fellows have seen the interesting little animal, which lives in a vertical burrow in soft stone, and so folds up its front parts as to form a remarkable flat stopper. The second crustacean was the *Dromia bicavernosa*, a medium-sized crab with a strange kidney-shaped cavity outside each eye hole, with a red margin, the use of which he could not divine. This was the first of a dozen papers from his pen on birds, fish, snakes, crustaceans, kangaroos, wallabies, whales, dolphins, and fossils. In collaboration with Dr. E. C. Stirling he wrote two papers on the *Genyornis newtoni*, and one on the *Phascolonus gigas* of Owen. He was largely responsible for the reproduction of the gigantic wombat, *Diprotodon australis*, whose skeleton is erected in the Australian section of the Adelaide Museum, building up its bones from the friable fossil remains found at Lake Callabonna The recognition of his scientific work and his friendliness are indelibly commemorated in a dozen or more species named after him by various authors, among whom I am pleased to number myself. Mr. Blackburn went further and created an insect genus of *Zietzia*. He accompanied me on some of my marine excursions in search of mollusca, and always proved himself an indefatigable collector, an intelligent scientist, and a very easy and agreeable companion.

We have also to record the death of Mr. G. G. Mayo, who had been a Fellow from 1874 till 1919, a period of 46 years, and who is now represented on our register by two of his children, Dr. Helen Mayo and Mr. Herbert Mayo, LL.B. A short tribute to his useful relationship to our Society was rendered last year when he resigned his Fellowship and may be found in Vol. XLIV.

J. C. VERCO.

Evening Meeting, September 8, 1921.

A Tholeiitic Basalt from Eastern Kangaroo Island.

(Communicated by Professor Walter Howchin.)

The evidence of igneous action of Tertiary date in the Kangaroo Island area has, so far, been indicated only in the neighbourhood of Kingscote, and to the west.

The rock, which is shortly described in this note, represents a further member of the Tertiary suite—developed in the vicinity of Cape Willoughby. Through the kindness of Professor Howchin, the writer has been able to study this rock, collected by him from a dyke cutting the older Palaeozoic or Proterozoic schists near Cuttle Fish Bay, Hundred of Dudley (Trans. Roy. Soc. S. Austr , vol. xxvii., 1903, pt. I., p. 82).

The hand specimen is a grey-black, fine-grained rock containing phenocrysts of felspar, visible with a low-power lens. There are also present a number of small spherical masses of brown colour which represent infilled amygdales. These do not exceed one-sixteenth of an inch in diameter.

Viewed in thin sections, the rock has the mineralogical composition and texture of a basalt. The phenocrysts consist of plagioclase and augite set in a ground-mass of hypocrystalline nature. The constituents of the ground-mass are augite, plagioclase, magnetite, brown glass, and the amygdale minerals, opal, and an undetermined zeolite.

The augite phenocrysts are usually subidiomorphic and reach in size 1½ mm. They are elongated parallel to the vertical axis. In convergent light they are seen to be of two types, a dominant one, biaxal, and in less amount an enstatite augite of uniaxial character. They are both colourless to greyish with well-developed prismatic cleavages, and commonly show twinning on 100. The plagioclase phenocrysts reach a similar dimension but are usually smaller. They show twinning after the Carlsbad and Albite laws, and less commonly the pericline. The composition approximates that of bytownite, with a refractive index of 1·57. A glomeroporphyritic texture is often apparent.

The ground-mass of augite, plagioclase, and glass has the typical intercertal fabric, the brown glass occurring as angular patches between the plagioclase laths. The felspar is a plagioclase of labradorite composition, with a lath-shaped habit, and the augite granules still preserve a tendency towards elongation parallel to the vertical axis. Grains of magnetite are uniformly distributed through the base. The amygdales of spherical shape are filled with a very low refracting substance, partly isotropic, and partly birefringent.

The isotropic material usually borders the vesicle, and the central part is filled with a birefringent mass of radiating zeolite fibres. Both these substances have a refractive index less than 1.51. The isotropic material shows irregular cracks, and has the properties of opal. Its reflective index is considerably below that of the brown glass. These zeolitic patches are developed quite irregularly between the constituents of the ground-mass.

In some cases the vesicles were formed prior to the final consolidation of the rock as they are surrounded, externally, by the ground-mass felspar laths arranged tangentially to the spherical surface of the vesicle.

This rock is thus distinctly related to the tholeiite type of basalt, but shows some affinities with the innimmorites, in the presence of a uniaxial augite, and the presence of opal in the vesicle substances indicates an acidity more comparable with the latter. The rock bears no relation petrographically with the Palaeozoic dyke rocks of the Blinman and Victor Harbour districts, and there can be no question of its relation to the Tertiary igneous rocks of the Kingscote area. The basalts of Kingscote have been shown by Stanley (Trans. Roy. Soc. S. Austr., vol. xxxiv, 1910, pp. 69-74) to be enstatite types of comparative high acidity (53% SiO_2). By the presence of the enstatite molecule in the monoclinic pyroxene, this tholeiitic basalt is petrographically linked with the enstatite basalts, and it is probable that they represent terms in a common differentiation series.

C E Tilley.

Evening Meeting, April 14, 1921.

Loranthus and Its Hosts.

Dr. J. B. Cleland exhibited specimens of *Loranthus* showing the remarkable resemblance each bore to the general appearance of the particular hosts. Thus *Loranthus exocarpi* on the cultivated olive (and oleander); *L. miraculosus* on *Myoporum platycarpum*; *L.* sp. near *L. gibberulus* on *Casuarina* and *L. linophyllus* on *Acacia Burkitti*, were in some instances almost indistinguishable when growing from the trees or bushes on which they were parasitic. Why this resemblance?

(1) The suggestion that the resemblance is a protective device of advantage to the mistletoe can at once be dismissed. The mistletoe, being spread by birds feeding on its fruits, is more likely to court observation than otherwise.

(2) May the resemblance be due to some hormone developed in the host reaching the parasite by means of the sap and thus modifying and controlling the development of the

parasite in the same way that it may influence the host's tissues? This view is ruled out of court by an examination of the specimens exhibited, amongst which we find examples in which the leaves of the mistletoe resemble (1) the leaves of the host, (2) the phyllodes of the host, and (3) the branchlets of the host. In other words, the hormone if present would be modifying in some instances different structures in the parasite to those in the host.

(3) The following, it is suggested, is the real explanation. The successful establishment of the parasite is probably due to its accommodating itself reasonably well to the normal supplies of food and water available from the host. If it required, owing to greater evaporation, more water than the host was capable of distributing, then the parasite would presumably die out just as a plant in the earth succumbs in drought. The water supply of the host will depend partly on the evaporation from the leaves or leaf substitutes. If these are protected from rapid loss (*e.g.*, are glazed, terete, etc.), then the mistletoe to survive must modify its leaves so as to let the escape of water by their means be relatively equivalent to that from a corresponding branch of the host. Otherwise, if the loss be much greater, the available water travelling up the host will be soon exhausted. Hence only those species of Loranth can develop on particular hosts whose leaves function similarly to the leaves or leaf substitutes of the host.

JOHN B. CLELAND.

Evening Meeting, April 14, 1921.

Old Native Camps at Commodore Point, Encounter Bay.

The native camps referred to in these notes are at the back of Commodore Point, in Sections 2311 and 2285 I visited them in January, 1921, and this is intended to record their condition at that date.

Commodore Point is a granite outcrop backed by sandhills. In these there are masses of travertine which were largely used by the natives for hearth-stones and, in the blown sand, these masses of blackened travertine often stand out as little hillocks. On digging into these, carbonized matter is found mixed with remains of food materials. Although one finds these ancient hearths scattered all through the sandhills at the sides and back of the Point, the main camp is just to the west of the Frenchman Rock.

This camp is about 300 yards long and 100 yards wide. The whole area is thickly covered with shells of *Donax epidermia* from the adjacent Middleton beach, and this cockle evidently formed the main food supply of the camp. The valves are present in countless millions. Mixed with these, sparingly, are shells of *Turbo undulatus*, *Fasciolaria*, *Fusus*, and a few other species. The surface is uneven and there are mounds rising as high as 10 ft., in places. Hearths, formed of circular collections of blackened travertine, are scattered everywhere. Amongst these are burial mounds, many of which have recently been exposed, and long bones, ribs, and hand and foot bones are plentiful. Owing to the burials being in a sitting position the skulls have been first exposed and generally carried away. On digging down the lower jaw is generally the first bone met with. The bones are in a well-preserved condition and are evidently those of primary burials; that is to say, they are not interments of bones from tree burials such as one often finds in *tumuli* on the lower Murray. In these the hand and foot bones are frequently partly or wholly missing. The camp is of very old date, and the extensive sand movements have sifted out the shells and stones so that successive strata are probably mixed and now rest on the hard pan.

The main object of the visit was to see what stone remains could be gathered. The stone implements of the Encounter Bay natives were of a most primitive kind, made to use in the camps and left there and not carried about. Those exhibited show the principal forms met with. The most common are the flat oval hammer stones which appear to have been used for cracking cockles. In form they are light and easily handled, and their edges show the marks of frequent percussion. More rarely, one finds stout circular stones with a well-marked depression on which cockles and Turbos were placed to be cracked. Then there are rough hand axes, or choppers, made by knocking flakes off a pebble of suitable size. These are similar to those found in camps on the Victorian coast, and of which I have specimens from Point Cook, near Melbourne, where there is a similar extensive camp.

Flat masses of granite are scattered about, brought from the adjacent beach, and are always polished with use on the upper-surface, while the lower is in the natural rough condition. These, probably, were used for grinding ochre, of which masses of the yellow and red varieties are met with. Small highly-polished stones were probably used to grind with. The search revealed no small chipped implements, but flakes of quartz are everywhere. These are of such a size and shape that they make excellent tools for opening the *Donax*, and I suggest that this was the use they were put to. The quartz must have been brought from some distant part, and Rosetta Head seems to be the nearest place where it occurs in quantity. High up on the saddle of Rosetta Head is a place which was very likely the source of this material, and chips are scattered about over a large area. The extreme hardness and fine edge of this material rendered the chips fit for their intended use without any secondary working. Chips of other material are less common, and some of them are pointed in form and may have been used as borers or gravers No large millstones are met with apart from the granite masses which may have been used as such, but one fragment with a concave surface is shown which is evidently of this nature.

Apart from the mollusca the only food remains are the otoliths of the mullowan, or butter fish, which occur in considerable numbers all over the camp, and this fish evidently largely contributed to the aboriginal food supplies.

R. H. PULLEINE.

Evening Meeting, May 12, 1921.

On the Methods Adopted by the Aborigines of Australia in the Making of Stone Implements, based on Actual Observation.

In my late visit to Central Australia I came into contact with some aboriginals that still used their native weapons Two of these, one quite destitute of clothing, were met with near the River Finke. They were carrying about half a dozen rabbits each, which they had killed by means of their wooden barbed-spears and throwing sticks, or womerahs. The womerahs had, as is usual, at the opposite end to the prong, a carefully-chipped stone implement, in the form of a gouge, which is used for shaping most of the wooden tools and weapons of the natives. From these men I obtained useful information as to the methods adopted by them in making their stone implements, whether by flaking, chipping, or otherwise. The information thus obtained throws important light on certain features that could not previously be explained.

It is well known that the stone commonly used by the aborigines as a braying stone, or hammer, was a naturally-formed, oval-shaped, waterworn stone, very fine in the grain. These so-called "hammer" stones are among the most common and widely distributed of aboriginal implements, and are frequently found on the sites of their old camping grounds. They give evidence of having been used by the abrasion or roughened appearance that occurs on some parts of the surface. It has been a little perplexing to find that some of these hammer stones show an abraded surface at one or both ends of the stone in its longer diameter, while others show the abrasion, not at the end, but at a little distance from the end, and on one or more of the lateral faces. In some cases the tool shows signs of use both at the ends and on the sides of the pebble.

The reason for this was explained by my native instructors. When a flake has to be struck from the core, the end of the hammer is used and a sharp blow is directed at a point near the edge of the previously prepared flat surface of the core. By this means a flake, possibly several inches in length, is struck off and shows a conchoidal fracture concentric to the point where the impact was made. To obtain this effect the striking tool must be used vertically and with considerable force. To work up a fine cutting edge by secondary chipping a different method is adopted. During the day on which I met the two aboriginals at the Finke I happened to have picked up a quartzite flake, that was chipped to some extent on one side, and also a round pebble that had been used as a hammer stone. I produced these from my pocket and showed them to the two natives With respect to the quartzite flake, they said, "Him no good." I then said to them, "Show me how you make him." One of the natives then took the quartzite in his left hand and the round stone, or hammer, in his right, holding the flake with its flat, or conchoidal side, uppermost Then, instead of using the hammer, end on, as is done when removing flakes from the core, he struck the edge of the flake by a sideways blow from the hammer, which produced a bevelled surface along the edge of the convex side of the flake. The object, in this case, was to make a womerah stone, but, as the native stated, the stone (a quartzite) was not a good kind of stone for this purpose. Womerah gouges are usually made from a very fine-grained porcelain-like stone, and are often an article of barter between the tribes.

This object-lesson explains not only the use of the smooth, oval-shaped pebbles (which might be more appropriately called *fabricators* rather than hammers), but also the origin of the two kinds of abrasion seen on these stones, as referred to above. I also ascertained that in the use of the stone gouges, or other cutting instruments, the stone knife is not directed away from the workman, as in the case of European usage in cutting with a steel knife, but is directed towards the workman.

The information obtained from the natives at the Finke was confirmed and still further illustrated by the natives met with on the Macumba Station.

WALTER HOWCHIN.

Evening Meeting, September 8, 1921.

ABSTRACT OF PROCEEDINGS

OF THE

Royal Society of South Australia

(Incorporated)

FOR THE YEAR, NOVEMBER 1, 1920, TO OCTOBER 31, 1921.

ORDINARY MEETING, NOVEMBER 11, 1920.

THE PRESIDENT (Sir Joseph C. Verco, M.D., F.R.C.S.) in the chair.

ELECTION.—John Neil McGilp a Fellow.

TREASURERSHIP.—The resignation of W. B. Poole as Hon. Treasurer was accepted with regret, and expressions of appreciation of his services were spoken; B. S. Roach was elected to the vacant position.

The HON. SECRETARY reported that the Council had handed to the Archives Department of the Public Library, for safe custody, certain old documents referring to the origin and early history of the Society, which would be catalogued and always available for reference.

RESOLVED: That the Society endorses the following two resolutions passed by the Section of Public Health and State Medicine of the Australasian Medical Congress, held this year in Brisbane, *viz.*:—

"8. That this Congress is of opinion that the time has arrived when a campaign of Preventive Medicine should be made real and effective, and that with the object of carrying out such an undertaking, and of fully utilizing existing agencies, the Commonwealth Government be approached and requested to appoint a Royal Commission to fully consider and report.

"That the *personnel* of such a Commission should contain a considerable percentage of unofficial medical practitioners, and also representatives of local governing bodies.

"9. That this Congress recognizes the importance of preventing the extinction of wild life in Australia, both on grounds of scientific interest and of public health. It urges on the various State Governments the advisability of making reservations, biological areas in which the protection of the remarkable Australian animals may be adequate."

In this connection it was pointed out that this Society, after a campaign of thirteen years, had succeeded in getting passed through Parliament the "Flinders Chase Act," establishing such a reserve in the western portion of Kangaroo Island under the control of a Board on which this Society and the University of Adelaide are represented.

THE PRESIDENT reported that the Council had made to Mr. F. R. Marston a grant in aid of research into the possibility of obtaining from azine precipitates samples of the pure proteolytic enzymes.

EXHIBITS.—Dr. PULLEINE, *pro* Mr. C. E. May, exhibited from near Pine Creek, Northern Territory, native copper in the form of large shot; gypsum crystals with inclusion resembling moss and also included bubbles; and from Darwin a rare shell *(Voluta bednalli)*. Dr. J. B. CLELAND exhibited a specimen of *Loranthus exocarpi*, Behr., parasitic on *Loranthus pendulus*, Sieber, the latter growing on *Eucalyptus odorata*, F. v. M., in Beaumont Common. The latter Loranth has been growing for twenty years or more, but has only recently been infected by the first-named. The first-named has, however, been growing on an oleander near by for very many years, and from this source, probably, has been distributed to a number of cultivated olive trees. A second instance of *Loranthus linophyllus* growing on *L. pendulus* has been seen near Clarendon. Also a bird's nest, decorated with wild flowers which had been worked into the lining and especially the entrance. The flowers, consisting of three spider orchids *(Caladenia dilatata*, R. Br.), a number of white everlastings *(Helichrysum Baxteri*, F. v. M.), and several heads of a brownish rush-like plant *(Luzula campestris*, Dec.) were quite fresh when the nest was found, having obviously been gathered that morning or the evening before. The birds had evidently exercised selection in their choice of material, having chosen the spider-like yellow-brown and purple orchids and the brownish rush-like heads, though these plants were not nearly so abundant as some others, for example a striking blue orchid. The nest was found at Clarendon on October 13, being empty of contents. Its original builder was *Pomatorhinus superciliosus*, Vig. and Horsf., but the old nest had been taken possession of, Dr. Morgan suggests, by the finch *Stagonopleura guttata* (Shaw). Prof. Cleland was indebted to Mr. J. M. Black and Dr. Rogers for the identification of the species referred to. Capt. S. A. WHITE exhibited a native skeleton recently ploughed up at the Reedbeds, showing mended fractures of leg and arm bones; also the pear-shaped fruit of a Western Australian Hakea, and the curious black "kangaroo paw" flower. Mr. A. M. LEA exhibited a collection of insects made by Mr. F. Parsons in the north-east corner of the State, and another by Mr. H. M. Hale in the

Flinders Ranges. Both collections contained several species new to science. He also exhibited roots of an apricot tree dying from the attacks of weevils, and apricot leaves and fruits destroyed by another species of weevil *(Desiantha nociva)*. Mr. A. R. RIDDLE discussed an apparently unrecorded phenomenon occurring in the electron type of X-ray tube, by means of which a brilliant blue light was produced.

ORDINARY MEETING, APRIL 14, 1921.

THE PRESIDENT (Sir Joseph C. Verco, M.D., F.R.C S.) in the chair.

NOMINATION.—R. J. Burton was nominated as Fellow.

PAPERS.—"Additions to the Flora of South Australia, No. 19," by J. M. BLACK; "Crinoids from the Cretaceous beds of Australia, with Description of a New Species," by Professor WALTER HOWCHIN, F.G.S.; "A Tholeiitic Basalt from Eastern Kangaroo Island," by C. E. TILLEY (communicated by Professor Howchin).

THE PRESIDENT reported that the Council had made a grant to Professor Wood Jones in aid of research into the Fauna and Flora of Nuyt Archipelago.

EXHIBITS. — Dr. PULLEINE exhibited palaeolithic stone implements from South Bruni Island, Tasmania, at the Easter encampment of the Tasmanian Field Naturalists, and made some remarks upon Tasmanian implements generally. Capt. S. A. WHITE exhibited the following birds:—*Tyto novaehollandiae* (Chestnut-faced Owl), from the blowhole on Nullarbor Plain, with *Tyto delicatula* for comparison; *Coracina robusta mentalis* (Southern Cuckoo Shrike), from South Australia, with *Coracina melanops* (Black-faced Cuckoo Shrike) from New South Wales and South Australia, and *Pteropodocys maxima* (Eastern Ground Cuckoo Shrike) from New South Wales for comparison; also specimen prints of Cayley's "Birds of Australia." Professor J. B. CLELAND exhibited specimens of *Loranthus*, showing their resemblance to their respective hosts [*vide* Miscellanea]; also portion of a branch of a sugar-gum *(Eucalyptus cladocalyx)* over 2 in. in diameter which broke off spontaneously at its juncture with the stem at 12.30 p.m. on February 19, 1921, the day being warm and muggy and the maximum shade temperature 91° F. During this month, in the neighbourhood of Adelaide, numerous large fallen branches were seen lying under these trees. Mr. J. H. Maiden, to whom the matter was referred, stated that owing to the liability of the branches of this species to fall in this way, its cultivation had largely gone out. The wood of the branch examined was very sappy. Also a number of portions of the roots of a mallee *(Eucalyptus* *oleosa*, F. v. M.) removed from a well, sunk beside the tree, at a depth of 50 ft. The roots are up to ½ in. or more in diameter and very porous, the opening of the tubes being just visible to the naked eye. The tree was growing about 70 miles north of Renmark in a slight depression. Being of rather luxuriant growth, a bore was put down beside it in search of water. At 115 ft., a portion of the mallee-root came up; at 124 ft. water was tapped. The well was now being sunk to reach this water, and when visited had reached 50 ft. Professor WOOD JONES showed a melanistic variety of the common opossum (*Trichosurus vulpecula*) which was taken when young from the pouch of a normally-coloured female; also a series of otoliths from South Australian fish. Mr. E. R. WAITE, on behalf of the South Australian Museum, showed a series of all the sea-horses known in South Australia, seventeen in number, including five new species. Mr. A. M. LEA exhibited some red mites, found in immense numbers on apricot trees, at Angaston, also pumpkins, in various stages, attacked by the squash-tip disease, a fungus that has destroyed more than half the past season's crop of pumpkins, melons, and marrows in South Australia.

ORDINARY MEETING, MAY 12, 1921.

THE VICE-PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTION.—R. J. Burton was elected a Fellow.

NOMINATION.—Gilbert Henry Dutton, B.Sc., F.G.S., was nominated as Fellow.

Notice of Motion by A. G. EDQUIST *re* planting of Morialta Reserve.

PAPERS.—"Notes on some Western Australian Chitons (Polyplacophora) with Additions to the Fauna, and the Description of a New Species of *Rhyssoplax*," by EDWIN ASHBY, F.L.S., M.B.O.U.; "Geological Memoranda (second contribution). Subjects: I., Miniature Serpuline 'Atolls'; II., Pseudo-Cryptozoön Structure; III., A Pre-historic Alluvial Fan at the Mouth of the Glen Osmond Gorge; IV., The Occurrence of Scoriaceous Boulders in the ancient gravels of the River Torrens," by Professor WALTER HOWCHIN, F.G.S.; "Notes on Old Native Camps at Commodore Point, Encounter Bay," by R. H. PULLEINE, M.B.

ORDINARY MEETING, JUNE 9, 1921.

THE VICE-PRESIDENT (R. H. Pulleine, M.B.) in the chair.

ELECTION.—Gilbert Henry Dutton, B.Sc., F.G.S., was elected a Fellow.

Resolved, on the motion of A. G. **Edquist**, seconded by Professor **Osborn**—"That this Society interest itself in the future planting of Morialta Reserve, and recommend that the Flora of the Reserve be kept typically Australian by the exclusion of exotic trees and shrubs."

Resolved—"That a copy of this resolution be presented to the Minister controlling the Reserve, by a deputation consisting of the President, Dr Pulleine (V P.), the Hon. Secretary, Professor Osborn, Professor Cleland, and Dr. Rogers."

Papers.—"The External Characters of Pouch Embryos of Marsupials, No. 2, *Notoryctes typhlops*," by Professor **Wood Jones**, D.Sc., F Z.S.; "Australian Coleoptera of the Family Malacodermidae," by A. M. **Lea**, F.E S.

Exhibits.—Professor **Howchin** drew attention to the variation in the present outline of the Morialta Fall from that shown in the coloured illustration of the same (then known as Glen Stuart) in George French Angas' book published in 1845, proving that there had been a slight recession in the falls since that date. Mr. **Edwin Ashby** exhibited some specimens of great historic interest, shells collected by the famous naturalists, Péron and Lesueur, of the ship "Le Géographe," under the command of Capt. Nicholas Baudin, who, in 1802, sailing round from eastern Australia, met Capt. Flinders in the "Investigator." The naturalists made some very valuable collections at the various places visited, especially at King Island, in Bass Strait. The specimens shown by Mr. Ashby are some of those collected while Baudin lay off King Island, and which, on the arrival of the explorers in Paris, were named by the famous French savant, De Blainville, in 1825. The name he gave to them was that of *Chiton lineolatus*. It is a rather interesting coincidence that the final recognition of De Blainville's shell Chiton, now *Ischnochiton lineolatus*, was only established by one of Mr. Ashby's papers published in the Royal Society's Transactions of last year. This result was made possible through information supplied by a Belgian specialist in this group of mollusca named Commandant Paul Dupius. In August last year, after a long silence due to grave illness, Mr. Ashby received a letter from him in which he says, "I shall have no time again to study further my Polyplacophora.. The Museum offered to me £100 to get my collection (less than it has cost me), but I do not like to put my collection where nobody will do any work about it. I prefer to give the whole lot to somebody interested with the matter, so I decided to send you my collection parcel by parcel." He then mentions some of the very valuable types and cotypes the collection contains, and concludes with the words, "No need to thank me at all; the whole pleasure I feel in sending my collection to the best man able to possess it is quite enough." Three parcels have already been received containing much valuable material, and these are to be followed by others from time to time. One of the shells shown still has the words "Ile King" written on the inside of the shell, no doubt in the handwriting of one or other of the famous naturalists Péron and Lesueur, adding thereby special interest to that particular specimen. Mr. Ashby also showed *Choriplax grayi*, H. Adams and Angas, 1864. The specimen shown had been found by a Mr. George Pattison near Cape Banks Lighthouse, who sent it to Dr. W. G. Torr, by whom it was placed in Mr. Ashby's hands for description. Professor Osborn showed a rust fungus (*Uromycladium tepperianum*) on various Acacias, with *U. simplex* for comparison; also downy mildew on vines (*Plasmopora viticola*), a pest recently appearing in South Australia, which could only be controlled by spraying. Professor Cleland showed a large mass of "spinifex" (*Triodia*, sp.) gum from the Roebourne district, north-western Australia. This is used by the natives for fixing barbs on their spears. Also fresh specimens and a water-colour sketch by Miss Fiveash of the stone-making fungus, *Polyporus basilapiloides*, McAlp. and Tepper, for which they proposed the generic name *Laccocephalum*. The fungus belongs to the section *ovinus* of *Polyporus*. It proves to be developed from a deep-buried heavy true sclerotium, on top of which a false sclerotium appears which has hitherto been the part found by collectors. The cap is coloured brown. It is not always reticulated. Also specimens of some rare or unusual puff-balls from Monarto South, *viz.*, *Secotium melanospermum*, Berk., the first finding since Drummond discovered the species in Western Australia over seventy years ago; *Phellorina strobilina*, only found twice before; a large *Tylostoma*; and *Battarea phalloides*, var. *Stevenii*. These fungi would be further discussed in a later paper. Mr. A. M. Lea exhibited two drawers of insects from the very fine and extensive collection recently given to the South Australian Museum by Mr. William White, of Fulham; many of the showy moths and grasshoppers, although taken fifty years ago, preserved their natural colours, but sometimes trimmed and stiffened by pasting strip of paper on underside of wings, and sometimes painted natural colour.

ORDINARY MEETING, JULY 14, 1921.

THE PRESIDENT (Sir Joseph C. Verco, M.D., F.R.C.S.) in the chair.

The President reported that the resolution, *re* Morialta Reserve, passed at the last meeting, had been presented to the Hon. Minister of Education, and that the deputation had received a favourable reply. He also reported the death of our Fellow, the Rev. D. T. Whalley.

National Parks, etc.—A letter was received from the Naturalists' Section and the Fauna and Flora Protection Committee, *re* proposed public meeting to urge the reservation of large areas for our native Fauna and Flora, and asking for the appointment of two delegates to a committee to make arrangements for same. Messrs. Edwin Ashby (Vice-President) and Walter Rutt (Hon. Secretary) were appointed.

Paper.—"The Rediscovery of *Choriplax grayi*, etc.," by Edwin Ashby, F.L.S., M.B.O.U.

Exhibits.—Mr. **Edwin Ashby** exhibited fossil *Loricella sculpta*, Ashby, from Table Cape, Tasmania. Five species of Western Australian parrots, *viz.*, *Barnardius semitorquatus*, Quoy. and Gaim., from Ellensbrook, in the south-west of the State, and from 20 miles west of Moora; *B. zonarius connectens*, Mat., from Moora, and from Watheroo; *Platycercus icterotis*, Kuhl., from Ellensbrook; *Purpureicephalus pileatus*, Vig., from Ellensbrook; *Psephotus multicolor*, Kuhl., from Watheroo. Professor J. B. **Cleland** exhibited water-colour drawings of two curious fungi—the beef-steak fungus recently introduced from Europe, and a fruiting portion of native bread. Dr. C. **Fenner** (for Dr. Johnson) exhibited sections of recent borings in Adelaide streets; fossil-bearing limestones from various localities; igneous rocks from Houghton; and belemnites from Central Australia. Mr A. M. **Lea** exhibited three Cypress *Lambertiana* trees that had been killed by jewel beetles (*Diadoxus scalaris*). The beetles lay their eggs on the trees near the ground and the larvae practically ringbark the tree and many of the roots, usually killing the trees and causing unsightly gaps in hedges. Mr. A. G. **Edquist** exhibited specimens of a mistletoe, *Loranthus exocarpus*, found growing on the oleander, olive, and *Pseudacacia*, but not showing any tendency to simulate the foliage of the hosts. Mr. **Keith Ashby** showed curious apple-like growths found when pruning apple trees, and believed to be produced without flowers.

Ordinary Meeting, August 11, 1921.

The President (Sir Joseph C. Verco, M.D., F.R.C.S.) in the chair.

The President reported that the Council had agreed to support three lectures by Dr. Richard Berry, Professor of

Anatomy in the University of Melbourne, to be given in Adelaide on September 2, 5, and 6, on "Child Welfare from the standpoint of Science, and its bearing upon National Efficiency."

THE PRESIDENT reported that, on the initiation of the Field Naturalists' Section, a public meeting would be held under the auspices of fifteen Societies interested, on August 18, to demonstrate the strong public opinion that exists in favour of more active and sympathetic steps being taken to set aside further areas of national reserves, and to support those already proclaimed for the preservation of the native Fauna and Flora.

In connection with this subject, Mr. A. H. ELSTON referred to an article in "The Scientific Australian," for July, on "Australian Fauna."

A letter was received from the Australasian Association for the Advancement of Science, enclosing resolutions *re* a Co-ordinated Investigation into Land and Freshwater Flora and Fauna of Australia and Tasmania.

PAPERS.—"Australian Coleoptera, Part 2," by ALBERT H. ELSTON, F.E.S.; "The Craters and Lakes of Mount Gambier," by CHARLES FENNER, D.Sc., F.G.S.

EXHIBITS.—Professor HOWCHIN exhibited scoriaceous lava from the sea coast at Streaky Bay. Mr. A. M. LEA showed a collection of insects recently made by Dr. A. M. Morgan in north-western Australia, including several new to science. Sir DOUGLAS MAWSON showed a relief model of the Adelaide Ranges, indicating a suggested route for a railway from Adelaide to near Tailem Bend. Capt. S. A. WHITE exhibited two species of *Xylometum* (Wonder, or Native Pear), *viz.*, *X. occidentalis*, from Western Australia, growing to a height of 25 ft.; and *X. pyriformis*, from Queensland, growing to a height of 20 or 30 ft. Also seeds of *Macrozamia Douglassi*, from Queensland, and of *M. Fraseri*, from Western Australia; *Casuarina torulosa*, destroyed by Black Cockatoos, from Fraser Island, Queensland; *Melaleuca Maideni*, *Boronia pinnata*, and *B. ledifolia*. Also the following birds:—*Falcunculus frontatus* (Yellow-bellied Shrike-Tit) and *Myzomela sanguineolenta* (Sanguineous Honey-eater), and coloured plates of birds and their eggs in connection with Cayley's "Birds of Australia" shortly to be published.

ORDINARY MEETING, SEPTEMBER 8, 1921.

THE PRESIDENT (Sir Joseph C. Verco, M.D., F.R.C.S.) in the chair.

THE PRESIDENT referred to the death, since last meeting, of two Ex-Fellows—Mr. A. H. C. Zietz, who was an active Fellow for 25 years, a notice of whose work appears upon another page; and Mr. G. G. Mayo, a Fellow for 46 years, of whose connection with the Society a notice appeared on page 379 of Volume XLIV. of our Transactions. He also congratulated Dr. Edward Angas Johnson on his election as a Fellow of the Royal Sanitary Institute of London.

Papers.—"On the Occurrence of Aboriginal Stone Implements of Unusual Types in the Tableland Regions of Central Australia"; and "Notes on the Methods adopted by the Aborigines of Australia in the Making of Stone Implements, based on Actual Observation," both by Professor Walter Howchin, F.G.S.

Exhibits.—Mr. L. Keith Ward showed flint chippings from Wilson Bluff, in the south-west corner of South Australia, near Eucla, and from Sponge Cove, at the head of the Bight, in both cases found on the top of the cliff. Capt. S. A. White showed specimens of the Red Cedar Twig Borer *(Hypsepsyla robusta)* and twigs of *Cedrela*, var. *Australis*, from the Queensland forests, showing the destructive work of the insect; also two species of freshwater shells from Lake Frome; small flies, which cluster in dense masses; and specimens of the wood, polished and unpolished, of the Oak *(Tarrietia argyrodendron* and *T. actinophylla)* Mr. A. M. Lea exhibited a new flea-beetle *(Mordellistena)* parasitic on white ants at Townsville, and some small objects, resembling insects' eggs, but which proved to be a deposit of lime particles, found adhering to a fowl's egg. Dr Angas Johnson showed gastroliths from a yabbie; ambergris from Port MacDonnell; and She Pine, native damsons *(Podocarpus elata)*, from Queensland, showing the expanded front stem.

Annual Meeting, October 13, 1921.

The President (Sir Joseph C. Verco, M.D., F.R.C.S.) in the chair.

The President welcomed as a visitor Sir Edgeworth David, Professor of Geology in the University of Sydney. He also referred to the death of Mr. W. L. Ware, a Fellow of the Society since 1878 and Hon. Auditor since 1910.

The British Science Guild (S.A. Branch) forwarded a letter referring to the series of Natural History Handbooks to be issued under its auspices, and soliciting subscriptions towards the cost of illustrating the same. The authors' services were being given gratuitously, and the Government had agreed to print and issue the books.

Nominations.—The following were nominated as Fellows: —Owen M. Moulden, M.B., B.Sc., Dr. Melville Birks, Professor T. Harvey Johnston, M.A., D.Sc, and Oscar W. Tiegs, M.Sc.

The Annual Report and Financial Statement were read and adopted.

Election of President.—Sir Joseph C. Verco having declined re-nomination, R. S. Rogers, M.A., M.D, was elected, and took the chair.

The following resolution was carried upon the motion of Professor Howchin, seconded by Mr. Walter Rutt:—"This meeting places on record its high appreciation of the services of Sir Joseph C. Verco as President of this Society during the past 18 years. He has seldom been absent from his duties in the chair, which he has filled with marked ability. His devotion to the interests of the Society has been unremitting, and by his personal monetary contributions, as well as by donations secured through his agency, the financial position of the Society has been greatly advanced. We trust that the Society may long enjoy the privilege of Sir Joseph's fellowship."

Election of Officers.—The following were elected for 1921-22:—*Vice-Presidents*, Sir Joseph C. Verco and Dr. Pulleine; *Hon. Treasurer*, B. S. Roach: *Members of Council*, Professors Howchin, Wood Jones, and Cleland and Capt. White; *Hon. Auditors*, W. C. Hackett and H Whitbread; *Representative on the Board of Governors of the S.A. Library*, etc., Professor Howchin.

Papers.—"Notes on the Geology of the Moorlands (South Australia) Brown Coal Deposits," by A. C. Broughton; "The Status of the Dingo," by Professor F. Wood Jones; "The Wing-venation of the *Leptoperlidae* (Order Perlaria) with description of a New Species of the genus *Dinotoperla* from Australia," by R. J. Tillyard, D.Sc. (communicated through A. M. Lea, F.E.S.); "Onchocerciasis of Queensland Cattle," by Professor T. Harvey Johnston, M.A., D.Sc. (communicated through Professor Cleland, M.D.); "Notes on the Gynostemium of *Diuris* and the Pollinary Mechanism of *Phajus*," by R. S. Rogers, M.D.

ANNUAL REPORT, 1920-21.

The Hon. Treasurer (Mr. W. B. Poole), in November, resigned his office through failing health, and Mr. B. S. Roach was appointed in his stead.

The Transactions this year include papers on a variety of subjects, Professor Walter Howchin, Dr. Charles Fenner, Mr. A. C. Broughton, and Mr. C. E. Tilley dealing with geological; Professor Wood Jones, Professor Harvey Johnston, Mr. A M Lea, Mr. A. H Elston, Mr. Ashby, and Dr. Tillyard with zoological: Dr. Rogers and Mr. J. M. Black with botanical; and Professor Howchin and Dr. Pulleine with ethnological subjects.

The exhibits at evening meetings have been numerous and interesting.

Reference was made in the last Annual Report to the need for additional shelving, the request for which was laid before the Government by the Board of Governors of the Public Library, etc.; but, so far, no result has followed.

The index to our publications for 1901-1920 is now complete and in the hands of the printers. The cost of printing and issuing the same will be a serious item in next year's expenditure.

Two grants in aid of research have been made during the year—one, to Mr. F. R. Marston, for research into the possibility of obtaining from azine precipitate samples of the pure proteolytic enzymes; and one to Professor Wood Jones, for research into the Fauna and Flora of Nuyt Archipelago Mr. Marston's work was delayed by the miscarriage of some apparatus, ordered from London, by the University, but he hopes to be able to report fully before the close of the summer vacation. Professor Wood Jones' reseaches have been in progress, and he hopes to obtain considerable new material during the forthcoming vacation.

The Public Library having established an Archives Department for the preservation and cataloguing of documents relating to the history of the State, the Council has deposited therein documents dealing with the early history of this Society, and of its connection with the Public Library, Museum, and Art Gallery of South Australia.

The International Catalogue of Scientific Literature was, for some years, financed by the Royal Society of London; but as the burden became too heavy an appeal was made to other scientific bodies, including our Society, to assist in defraying the cost. This appeal having met with a poor response, the publication of the catalogue will probably not be resumed, which would be a serious loss to the scientific world.

The Society has given its support to various propaganda of a scientific nature. A deputation from the Society waited upon the Government to urge that the planting of the Morialta Pleasure Resort be kept typically Australian by the exclusion of exotic trees and shrubs. It was also represented at a public meeting, held in the Town Hall, under the chairmanship of His Excellency the Governor, to advocate the establishment of larger reserves for native Fauna and Flora. It was also one of the Societies which arranged for the delivery, by Professor R. J. A. Berry, of Melbourne, of three lectures upon "Child Welfare from the standpoint of Science, and its bearing upon National Efficiency." At the conclusion of these lectures a resolution was carried that, "In the opinion of this meeting it is essential that effective measures be taken in the immediate future for the investigation, study, and solution of the problem associated with the mental status and development of the children of South Australia." The provisional committee appointed to carry this resolution into effect, including five Fellows of this Society, appointed a sub-committee to consider an effective plan of action, and to report to the full committee. It is hoped that the result of such action will be the growth of a sounder public opinion upon these subjects.

The present membership of the Society comprises 9 Honorary Fellows, 4 Corresponding Members, 81 Fellows, and 1 Associate.

JOS. C. VERCO, *President.*
WALTER RUTT, *Hon. Secretary.*

September 30, 1921.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

REVENUE AND EXPENDITURE FOR 1920-21.

	£	s.	d.	£	s.	d.
To Balance October 1, 1920				602	0	8
,, Subscriptions—						
Royal Society	94	15	0			
Field Naturalists' Section ...	32	16	3			
				127	11	3
,, Grants from Government—						
On Subscriptions	75	13	4			
For Printing Reports and Scientific Investigations ...	150	0	0			
				225	13	4
,, Receipts for use of Room by other Societies	4	0	0			
,, Sale of Publications	3	6	9			
,, Discount allowed	0	6	10			
,, Savings Bank Interest	13	9	2			
,, Interest transferred from Endowment Fund	160	12	0			
				181	14	9
				£1,137	0	0

	£	s.	d.	£	s.	d.
By Transactions—						
Printing	234	0	5			
Illustrating	41	14	0			
Publishing	9	19	3			
				285	13	8
,, Grants—						
Field Naturalists' Section ...	45	0	0			
Scientific Investigations ...	74	16	7			
Parks and Flora Reserve ...	1	1	0			
				120	17	7
,, Library—						
Librarian, Cataloguing, Receiving, and Issuing	39	10	6			
Indexing	66	13	0			
				106	3	6
,, Sundries—						
Cleaning and Lighting ...	8	6	1			
Printing, Postage, Stationery	12	9	11			
Insurance	2	10	8			
Advertising	3	4	9			
Screen	1	15	0			
				28	6	5
,, Balance September 30, 1921—						
Savings Bank of S.A.	312	7	3			
Bank of Australasia	283	8	3			
Cash in Hand	0	3	4			
				595	18	10
				£1,137	0	0

Audited and found to be correct—

W. CHAMPION HACKETT, } *Hon. Auditors.*
HOWARD WHITBREAD, }

Adelaide, October 1, 1921.

B. S. ROACH, *Hon. Treasurer.*

ENDOWMENT FUND.

(Capital, £3,844 6s. 10d.]

	£	s.	d.	£	s.	d.
1920—October 1.						
To Balance	3,797	17	6			
,, Discount on Stock redeemed ...	46	9	4			
				3,844	6	10
,, Interest received on Government Stock	160	8	8			
,, Savings Bank Interest	0	3	4			
				160	12	0
				£4,004	18	10

	£	s.	d.	£	s	d
1921—September 30.						
By £2,000 S.A. Government Stock at 3¾%	1,997	10	0			
,, £500 S.A. Government Consolidated 3% Stock at cost ...	292	8	9			
,, £100 S.A. Government Inscribed Stock, 5%	100	0	0			
,, £650 S.A. Government Inscribed Stock, 5½%, at par ...	650	0	0			
,, £800 S.A. Government Inscribed Stock, 6%, at par ...	800	0	0			
,, Savings Bank Account ...	4	8	1			
				3,844	6	10
,, Interest transferred to Revenue Account				160	12	0
				£4,004	18	10

Audited and found correct—
W. Champion Hackett, } *Hon. Auditors.*
Howard Whitbread, }

B. S. Roach, *Hon Treasurer.*

Adelaide, October 1, 1921.

DONATIONS TO THE LIBRARY

FOR THE YEAR ENDED SEPTEMBER 30, 1921.

TRANSACTIONS, JOURNALS, REPORTS, ETC., presented by the respective governments, societies, and editors.

AUSTRALIA.

AUSTRALASIAN INSTITUTE OF MINING ENGINEERS. Proc., no. 38-40. Melb. 1920-21.
AUSTRALIA. *Bureau of Census and Statistics.* Official year-book, no 13. Melb 1920.
——— *Bureau of Meteorology.* Rain-map, 1919-20.
——— *Institute of Science and Industry.* Bull. 17, 19-21.
——— ——— Science and Industry, v. 2, no. 9-12. Melb.
AUSTRALIAN INSTITUTE OF TROPICAL MEDICINE. Report, 1917-19. Townsville. 1918-20.
NORTHERN TERRITORY. Report of Administrator, 1920.

SOUTH AUSTRALIA.

PUBLIC LIBRARY, MUSEUM, AND ART GALLERY OF S.A. Records of S.A. Museum, v. 1, no. 4; 2, no. 1.
——— Report, 1919-20. Adel. 1920.
ROYAL GEOGRAPHICAL SOCIETY OF AUSTRALASIA (S.A. BRANCH). Proc., v. 20. Adel. 1921.
SOUTH AUSTRALIA. *Dept. of Mines.* Review of mining operations in S.A., no. 32-33. Adel. 1920-21.
SOUTH AUSTRALIAN NATURALIST, v. 2. Adel. 1920-21.
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LIST OF FELLOWS, MEMBERS, Etc.

AS EXISTING ON

SEPTEMBER 30, 1921.

Those marked with an asterisk have contributed papers published in the Society's Transactions.

Any change in address should be notified to the Secretary.

Note.—The publications of the Society will not be sent to those whose subscriptions are in arrears.

Date of Election.

Honorary Fellows.

1910. *Bragg, Sir W. H., K.B.E., M.A., D.Sc., F.R.S., Professor of Physics, University College, London (Fellow 1886).
1893. *Cossmann, M., 110, Faubourg Poissonnière, Paris.
1897. *David, Sir T. W. Edgeworth, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S., F.G.S., Professor of Geology, University of Sydney.
1905. Gill, Thomas, C.M.G., I.S O., Glen Osmond.
1905. *Hedley, Chas., Assistant Curator, Australian Museum, Sydney.
1892. *Maiden, J. H., I.S.O., F.R.S., F.L.S., Director Botanic Gardens, Sydney, New South Wales.
1898. *Meyrick, E. T., B.A., F.R.S., F.Z.S., Tohrnhanger, Marlborough, Wilts, England.
1894. *Wilson, J. T., M.D., Ch.M., Professor of Anatomy, Cambridge University, England.
1912. *Tepper, J. G. O., F.L.S., Elizabeth Street, Norwood (Corresponding Member 1878, Fellow 1886).

Corresponding Members.

1913. *Carter, H. J., B.A., Wahroonga, New South Wales.
1909. *Johncock, C. F., Clare.
1905. Thomson, G. M., F.L.S., Dunedin, New Zealand.
1908. *Woolnough, Walter George, D.Sc., F.G.S. (Fellow 1902).

Fellows.

1895. *Ashby, Edwin, F.L.S., M.B.O.U., Blackwood.
1917. Bailey, J. F., Director Botanic Garden, Adelaide.
1902. *Baker, W. H., F.L.S., King's Park.
1902. *Black, J. McConnell, 82, Brougham Place, North Adelaide.
1912. *Broughton, A. C., Young Street, Parkside.
1911. Brown, Edgar J., M.B., D.Ph., 3, North Terrace.
1883. *Brown, H. Y. L., 286, Ward Street, North Adelaide.
1893. Brummitt, Robert, M.R.C.S., Northcote Ter., Medindie.
1916. *Bull, Lionel B., D.V.Sc., Laboratory, Adelaide Hospital.
1921. Burton, R. J., Fuller Street, Walkerville.

1907. *Chapman, R. W., M.A., B.C.E., F.R.A.S., Professor of Engineering and Mechanics, University of Adelaide.
1904. Christie, W., 49, Rundle Street, Adelaide.
1895. *Cleland, John B., M.D., Professor of Pathology, University of Adelaide.
1907. *Cooke, W. T., D.Sc., Lecturer, University of Adelaide.
1912. Corbin, H. H., B.Sc., University of Adelaide.
1914. Cornish, K. M., Coast View, Adelaide Road, Glenelg.
1916. Darling, H. G., Franklin Street, Adelaide.
1887. *Dixon, Samuel, Bath Street, New Glenelg.
1915. Dodd, Alan P., Gordon Vale, *via* Cairns, Queensland.
1921. Dutton, G. H., B.Sc., F.G.S., University of Adelaide.
1911. Dutton, H. H., B.A. (Oxon.), Anlaby,
1902. *Edquist, A. G., 2nd Avenue, Sefton Park.
1918. *Elston, A. H., F.E.S., 69, Lefevre Terrace, North Adelaide.
1917. *Fenner, Chas. A. E., D.Sc., F.G.S., Education Department, Adelaide.
1914. Ferguson, E. W., M.B., Ch.M., Gordon Road, Roseville, Sydney.
1919. Glastonbury, O. A., Adelaide Cement Co., Brookman Buildings.
1904. Gordon, David, c/o D. & W. Murray, Gawler Place, Adelaide.
1880. *Goyder, George, A.M., F.C.S., Gawler Place, Adelaide.
1910. *Grant, Kerr, M.Sc., Professor of Physics, University of Adelaide.
1904. Griffith, H., Brighton.
1916. Hackett, W. C., 35, Dequetteville Terrace, Kent Town.
1916. Hancock, H. Lipson, A.M.I.C.E., M.I.M.M., M.Am.I.M.E., Kennedya, Wallaroo Mines.
1896. Hawker, E. W., F.C.S., East Bungaree, Clare.
1883. *Howchin, Professor Walter, F.G.S., "Stonycroft," Goodwood East.
1918. Ising, Ernest H., Loco. Department, Islington.
1912. Jack, R. L., B.E., Assistant Government Geologist, Adelaide.
1893. James, Thomas, M.R.C.S., Tranmere, Magill.
1918. Jennison, Rev. J. C., Crocodile Islands, Northern Territory.
1910. *Johnson, E. A., M.D., M.R.C.S., 295, Pirie Street, Adelaide.
1920. *Jones, F. Wood, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., Professor of Anatomy, University of Adelaide.
1918. Kimber, W. J., Gaza.
1915. *Laurie, D. F., Agricultural Department, Victoria Square.
1897. *Lea, A. M., F.E.S., South Australian Museum, Adelaide.
1884. Lendon, A. A., M.D. (Lond.), M.R.C.S., Lecturer in Obstetrics, University of Adelaide, and Hon. Physician, Children's Hospital, North Adelaide.
1888. *Lower, Oswald B., F.Z.S., F.E.S., Broken Hill, N.S.W.
1914. Mathews, G. M., F.R.S.E., F.L.S., F.Z.S., Foulis Court, Fair Oak, Hants, England.
1905. *Mawson, Sir Douglas, D.Sc., B.E., Professor of Geology, University of Adelaide.
1920. Mayo, Herbert, LL.B., Brookman Buildings, Grenfell Street.

1919. MAYO, HELEN M., M.B., B.Sc., 47, Melbourne Street, North Adelaide.
1920. MCGILP, JOHN NEIL, Napier Terrace, King's Park.
1907. MELROSE, ROBERT THOMSON, Mount Pleasant.
1897. *MORGAN, A. M., M.B., Ch.B., 46, North Terrace, Adelaide,
1913. *OSBORN, T. G. B., D.Sc., Professor of Botany, University of Adelaide.
1886. POOLE, W. B., 6, Rose Street, Prospect.
1911. POOLE, HIS HONOR JUSTICE T. S., K.C., B.A., LL.B., Supreme Court, Adelaide.
1908. POPE, WILLIAM, Eagle Chambers, Pirie Street.
1907. *PULLEINE, R. H., M.B., 3, North Terrace, Adelaide.
1916. RAY, WILLIAM, M.B., B.Sc., Victoria Square, Adelaide.
1885. *RENNIE, EDWARD H., M.A., D.Sc. (Lond.), F.C.S., Professor of Chemistry, University of Adelaide.
1913. *RIDDLE, A. R.
1911. ROACH, B. S., Education Department, Flinders Street, Adelaide.
1919. *ROBERTSON, PROFESSOR T. B., University of Adelaide.
1905. *ROGERS, R. S., M.A., M.D., Hutt Street, Adelaide.
1919. *ROWE, ALAN, Hon. Custodian of Archaeological Collection, South Australian Museum.
1869. *RUTT, WALTER, C.E., College Park, Adelaide.
1891. SELWAY, W. H., Treasury, Adelaide.
1920. SIMPSON, A. A., C.M.G., Burnside.
1906. SNOW, FRANCIS H., National Mutual Buildings, King William Street.
1910. *STANLEY, E. R., Government Geologist, Port Moresby, Papua.
1907. SWEETAPPLE, H. A., M.D., Park Terrace, Parkside.
1897. *TORR, W. G., LL.D., M.A., B.C.L., Brighton, South Australia.
1894. *TURNER, A. JEFFERIS, M.D., F.E.S., Wickham Terrace, Brisbane, Queensland.
1878. *VERCO, SIR JOSEPH C., M.D. (Lond.), F.R.C.S., North Terrace, Adelaide.
1914. *WAITE, EDGAR R., F.L.S., Director South Australian Museum.
1912. WARD, LEONARD KEITH, B.A., B.E., Government Geologist, Adelaide.
1878. WARE, W. L., King William Street.
1920. WEIDENBACH, W. W., A.S.A.S.M., Glencoola, Glen Osmond.
1904. WHITBREAD, HOWARD, c/o A. M. Bickford & Sons, Currie Street, Adelaide.
1912. *WHITE, CAPTAIN S. A., C.M.B.O.U., "Wetunga," Fulham, South Australia.
1920. *WILTON, PROFESSOR J. R., D.Sc., University of Adelaide.
1912. *ZIETZ, F. R., South Australian Museum.

ASSOCIATE.

1904. ROBINSON, MRS. H. R., "Las Conchas," Largs Bay, South Australia.

APPENDIX.

FIELD NATURALISTS' SECTION

OF THE

Royal Society of South Australia (Incorporated).

THIRTY-EIGHTH ANNUAL REPORT OF THE COMMITTEE

FOR THE YEAR ENDED SEPTEMBER 30, 1921.

The Committee has pleasure in presenting the Thirty-eighth Annual Report of the Section. The membership is now 132, as compared with 112, which was last year's total.

The excursions have been well attended, and the leaders have been well repaid by the keen interest shown in the study of the various branches of Natural History.

Twenty excursions have been held—one on Forestry, six on Botany, four on Geology and Minerals, two on General Subjects, one each on Zoology and Pond Life, two on Shore Life, one Dredging Trip, and a visit to the Museum and to the Botanic Gardens.

Ten Public Lectures were given, and the attendances were very good. Seven of these were full evening addresses, the other three were given as Lecturettes by eight members of the Section.

"The South Australian Naturalist" has been published regularly, and during the year its pages have been increased and illustrations introduced.

A badge has been adopted and is being sold to members at cost price. The design—Sturt peas—has been much admired and a block made to use on the cover of the Journal.

During the year a sub-committee was formed to consider "Vernacular Plant Names." The lists issued by the Victorian Field Naturalists' Club have been obtained, and the sub-committee is now prepared to push on with the work.

The Section's first comprehensive Wild Flower Show was held in October, 1920, and proved very successful. The gross takings were £60 2s. 9d., and the expenses were £33 11s. 7d., leaving a credit balance of £26 11s. 2d.

We have to record with deep regret the loss, by death, of several members. The late Mr. E. H. Lock was a long-standing, active member who did valuable work as Secretary for a number of years and for a term as Chairman. The late Mr. A. M. Drummond was a member of long standing, and the late Mr. G. A DeCaux was a recent member.

We have to thank the Editors of *The Register* and *Journal* for their interest in the Section and for the publication of a series of Nature Notes in their papers. We feel that their publication has aroused great public interest not only in this Section, but in the general study of natural history.

Library.—The Librarian (Miss I. Roberts) reports that there has been a keen demand for books during the year. This is due to the addition of many interesting and valuable volumes, purchased by part of the proceeds of the first Wild Flower Exhibition. Thirty books have been added, covering most of the natural history subjects. Thanks are due to Mr. W. C. Hackett for his gift of copies of "The Garden and Field."

At present the Library is cramped for room, and commodious shelves for the proper arranging of the books are urgently needed.

Charles Fenner, *Chairman.*

Ernest H. Ising, *Hon. Secretary*

September 20, 1921.

THIRTY-SECOND ANNUAL REPORT OF THE NATIVE FAUNA AND FLORA PROTECTION COMMITTEE

Four meetings have been held during the year.

Following upon much correspondence and deputations to the Minister of Industry in reference to the protection of trees along roadsides, it is satisfactory to report that it is the intention of the Government to introduce a Bill before Parliament during the present session.

Matters in connection with Flinders Chase are not at all satisfactory. The Government has so far failed to give financial support to the Board empowered to carry on the Reserve. Without monetary assistance it is impossible to carry out the programme of improvements, tree planting, and stocking with animals, that has been drawn up in readiness to proceed when funds are available.

Our Chairman (Capt. S. A. White) has attended meetings of the Flinders Chase Board, interviewed Ministers, and visited Kangaroo Island, in his endeavour to get the Government to finance the Board, and has been Acting Chairman of the Board since the Hon. John Lewis' resignation.

A report having been received *re* destruction of Seals on Pearson Island (a Reserve), a deputation, consisting of the informant and delegates from this committee, waited upon the Minister of Industry on March 8, and asked that adequate protection be given to Seals on reserved areas. The Minister promised to enquire into it, and would, so far as possible, prevent a recurrence of the slaughter. The Minister has since asked that the committee state exactly what waters and islands they desired as a reserve for Seals.

The Chairman was instrumental in securing a conviction against half-castes for destroying native birds at Meningie, but unfortunately the fine was only nominal.

On August 16 a large meeting of Nature lovers was held in the Adelaide Town Hall, in which members of the committee took a prominent part, and the gathering was addressed by Capt. White, Messrs. E. Ashby and Edgar R. Waite. The meeting was called as a result of a conference between the Field Naturalists' Section and this committee with the idea of awakening the public to the need of protection for our Fauna and Flora.

Through evidence brought before them by this committee the Government decided to alter the close season for Kangaroos and Wallabies, from the six months ending December 31, to the six months ending March 31. By adopting the later period it is hoped that it would prevent the heavy slaughter of these marsupials when they came in to water during the hot summer months.

Our Chairman during the year has addressed numerous gatherings, in country and metropolitan centres, on the subject of native birds and their need for protection, and in this manner was largely responsible for the better understanding of the need for further necessary legislation. He had also visited the Coorong and the nesting islands of Pelicans and Swans, and found that the birds were generally unmolested. It is gratifying to learn that upon an island, not previously used as a breeding ground, at least 800 young pelicans had been successfully reared during the season.

It is with deep regret that we have to record the death of Mr. E. H. Lock, a valued and hard-working committee-man.

Owing to Mr. Andrew having removed from Adelaide, Mr. J. N. McGilp was elected Hon. Secretary in his stead.

The committee has found that gradually the public are awakening to the necessity of preserving our Fauna and Flora; in this connection mention might be made of the receipt of a letter from Mr. Sinclair asking that a large area on Eyre Peninsula, *i.e.*, Hundred of Flinders, be set apart as a Reserve for Kangaroos and Emus. As Mr. Sinclair is the largest leaseholder in this Hundred, the committee had no hesitation in supporting, and has asked the Minister of Industry to do everything possible to carry out Mr. Sinclair's wish.

The committee calls the attention of all Nature lovers to the fact that Thistle Island, near Port Lincoln, is for sale. This, it is thought, could be purchased at a reasonable price, and as it is an admirable spot for protecting our animals, a good opportunity is presented for anyone interested to start a private reservation, as is now common in the United States of America.

J. NEIL MCGILP, *Hon. Secretary.*

September 20, 1921.

FIELD NATURALISTS' SECTION OF THE ROYAL SOCIETY.

Statement of Receipts and Expenditure for Year ended September, 1921.

General Account.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
By Members' Subscriptions	33	7	6	To Refund to Excursion Account	7	16	10
,, Profit from Wild Flower Show . .	26	11	2	,, Printing	42	8	3
,, Grant from Royal Society	45	0	0	,, Postages	15	17	5
,, Advertisement in F.N. Magazine .. .	1	15	0	,, Hire of Hall and Lantern	6	14	6
,, Sale of Badges	5	2	6	,, Stationery	0	15	3
,, Bank Interest	0	9	4	,, Library Account	11	11	2
,, Sale of F.N. Magazines ..	0	19	1	,, Badges	12	17	6
,, Loan from Excursion Account .	18	3	10	,, Members' Subscriptions paid to Royal Society	32	16	3
				,, Members' Subscriptions due to Royal Society	0	11	3
	£131	8	5		£131	8	5

By Balance in Bank, 11s. 3d.

Excursion Account.

	£	s.	d.		£	s.	d.
By Balance Brought Forward .. .	1	5	5	To Hire of Motors .	53	10	0
,, Refund from General Account . .	7	16	10	,, Hire of Dredge . .	3	0	0
,, Excursion Fares	66	11	6	,, Tips to Sailors	0	5	0
				,, Refreshments . . .	0	13	6
				,, Loan to General Account ..	18	3	10
				,, Balance in Bank	0	1	5
	£75	13	9		£75	13	9

By Balance in Bank, 1s. 5d.

Audited and found correct,

Walter D. Reed, F.C.P.A., } *Auditors.*
Alec J. Morison,

Adelaide, November 8, 1921.

Beavis B. Beck, *Hon. Treasurer.*

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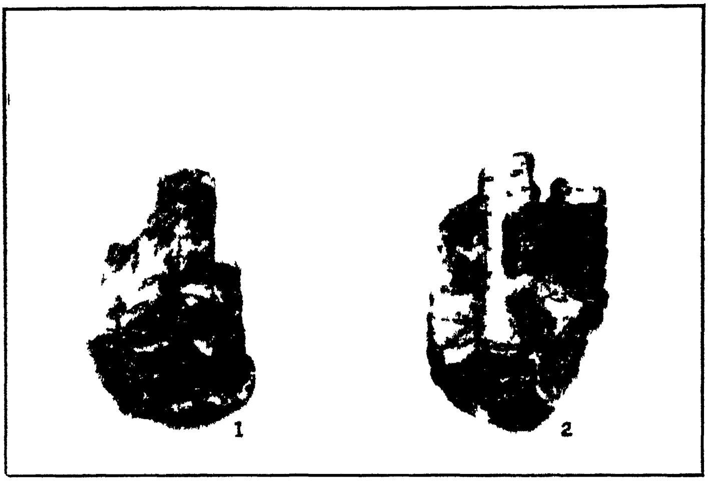
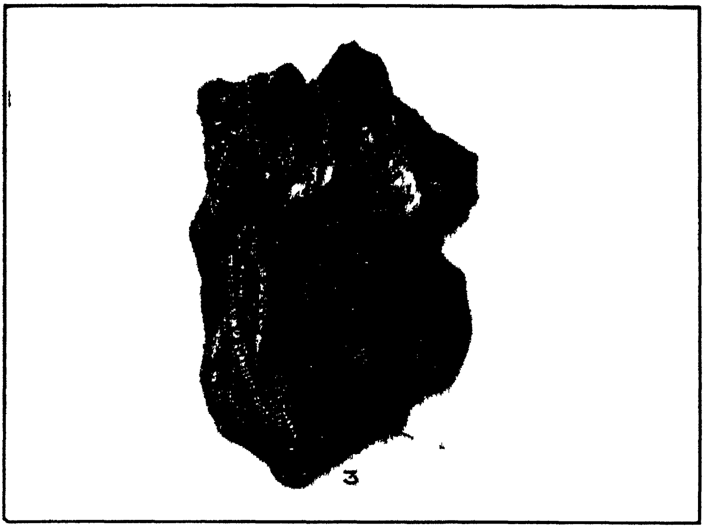


Isocrinus australis (Moore)



Isocrinus parvus, n sp

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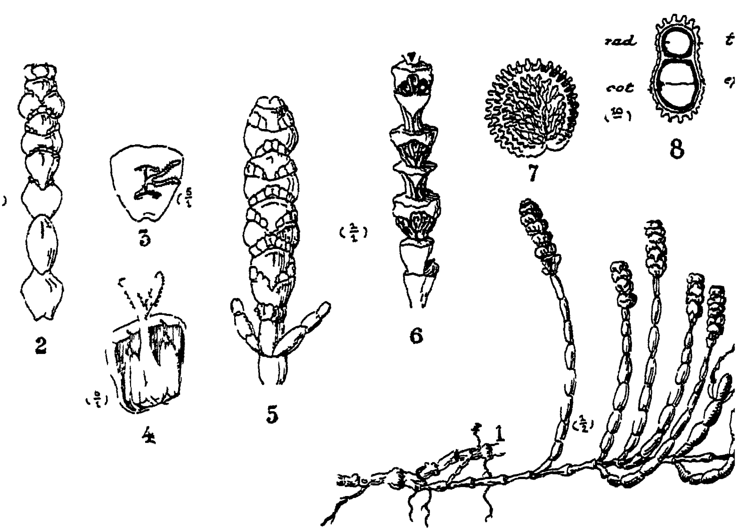
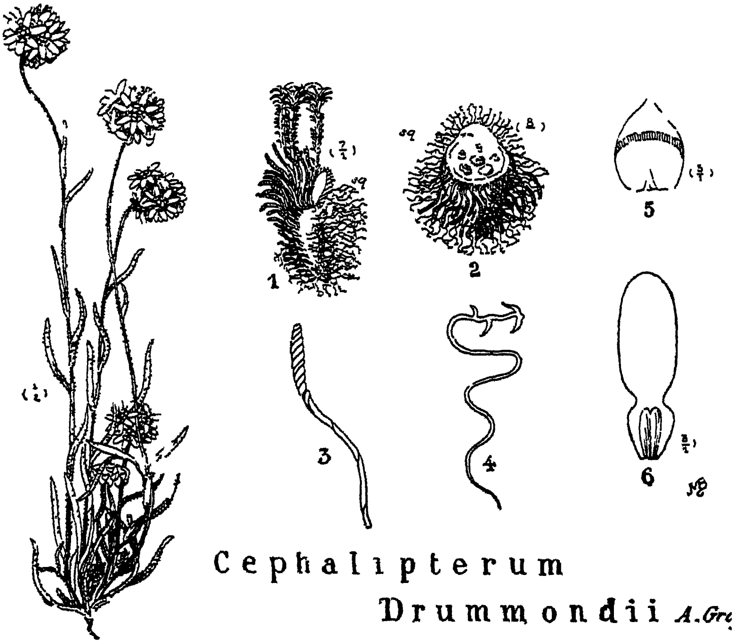
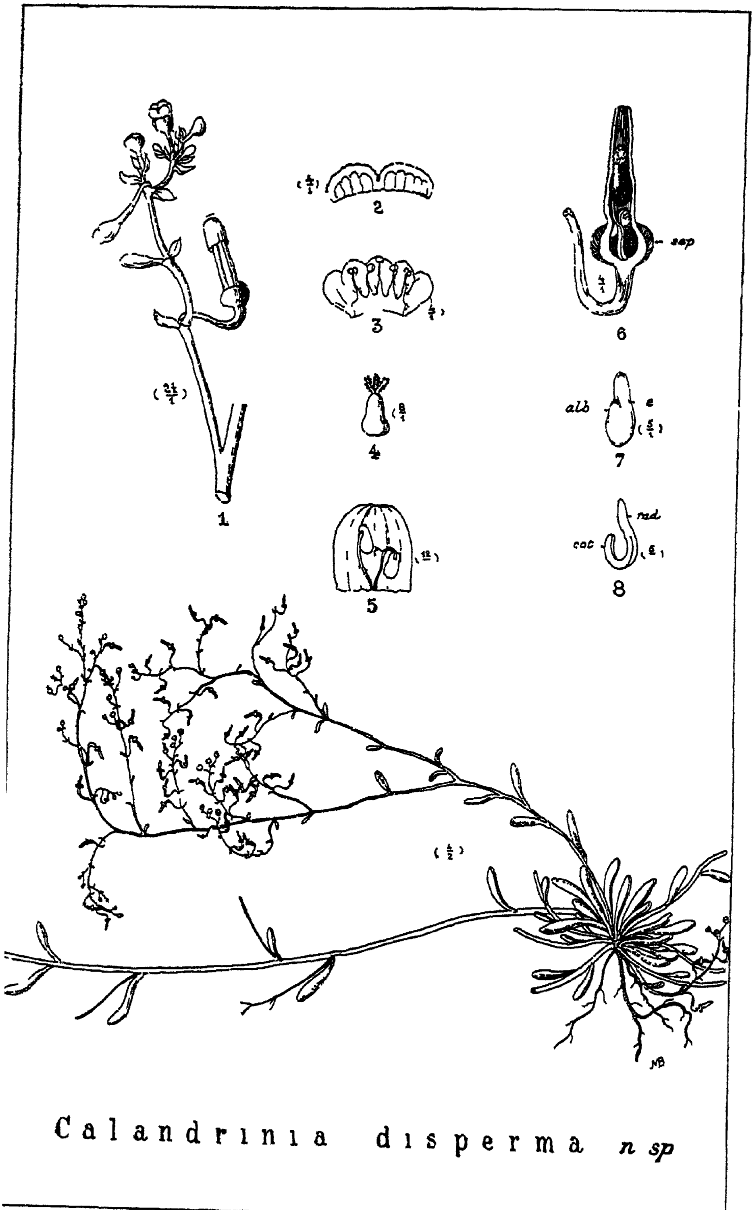


alicornia pachystachya *n sp.*



Cephalipterum Drummondii *A.Gr*



Calandrinia disperma *n sp*

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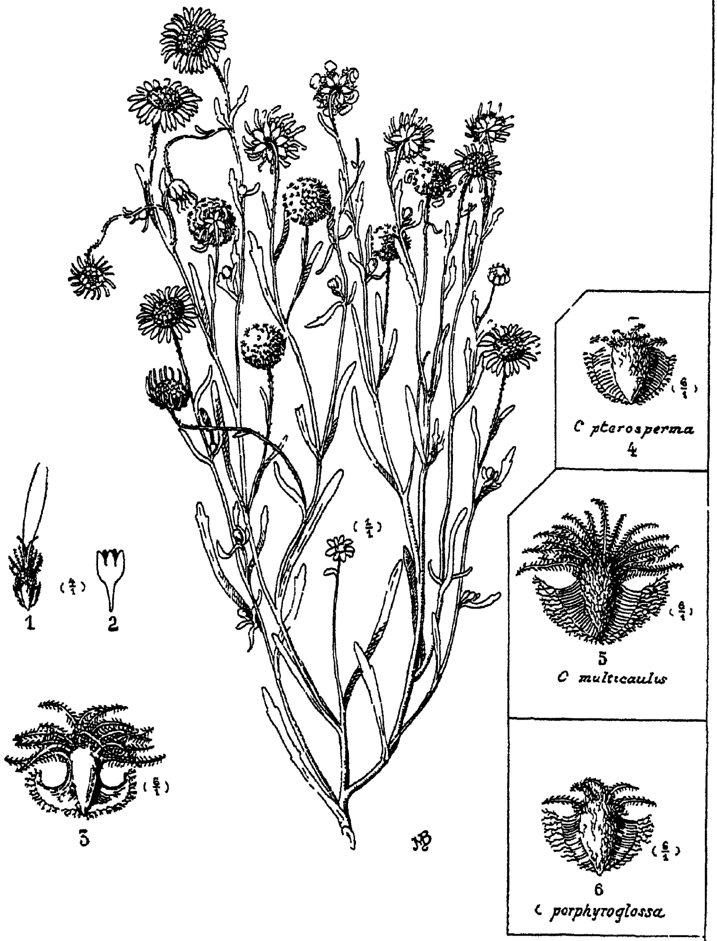

Calotis ancyrocarpa *n sp.*

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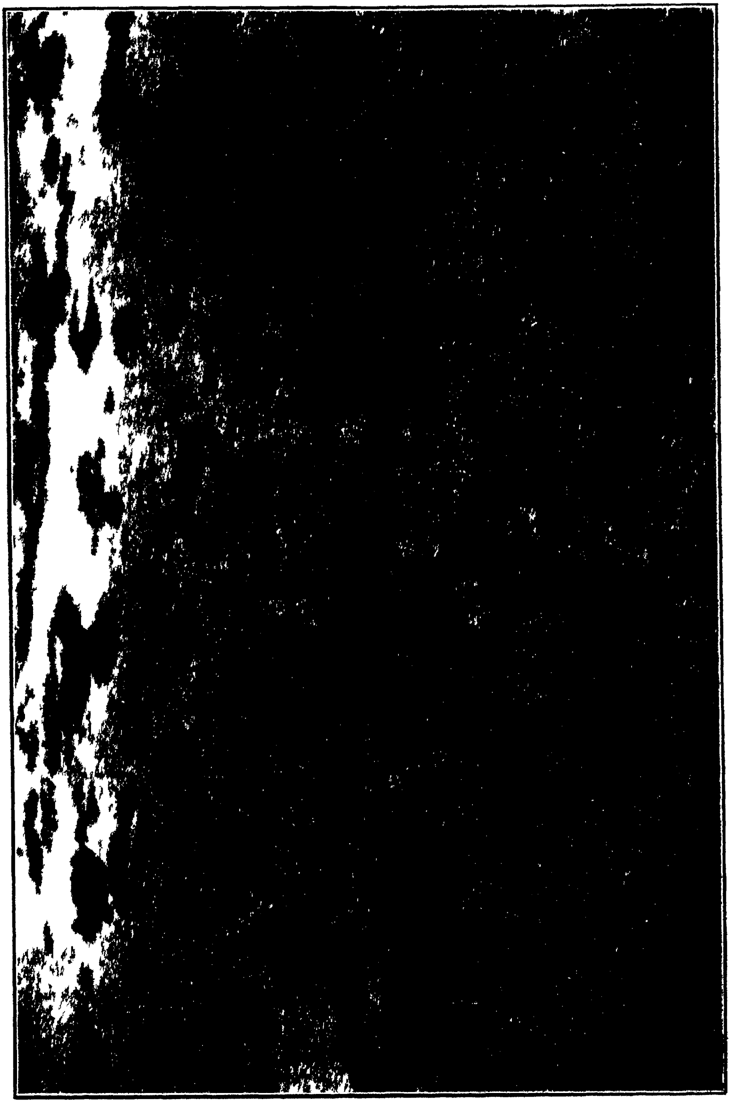

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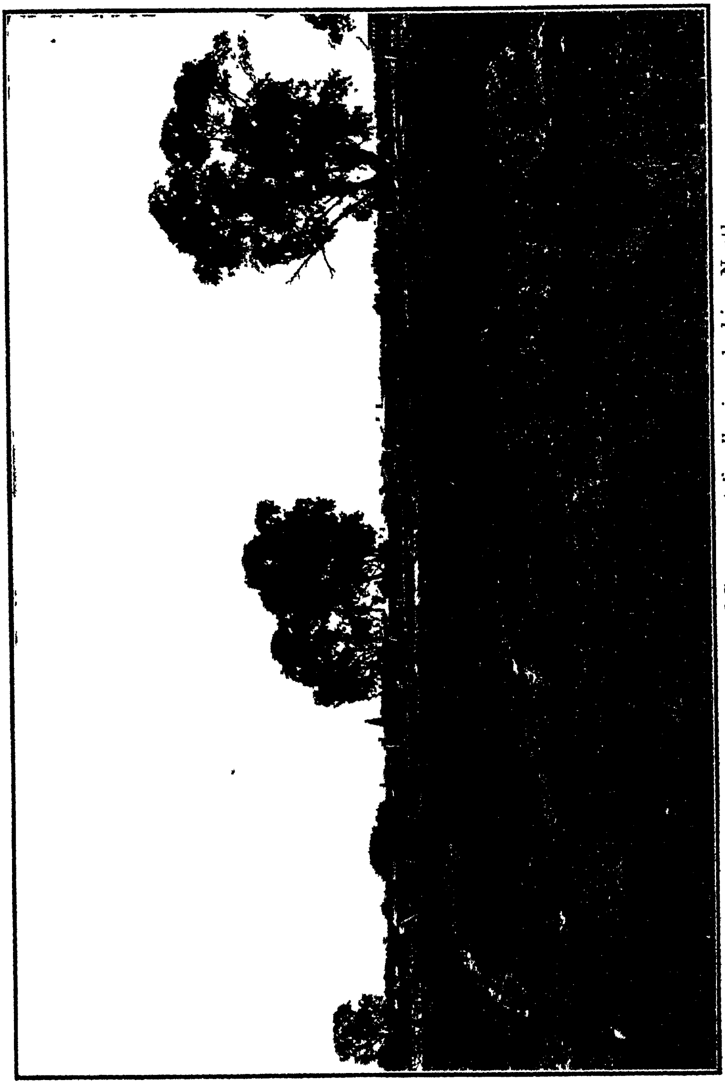

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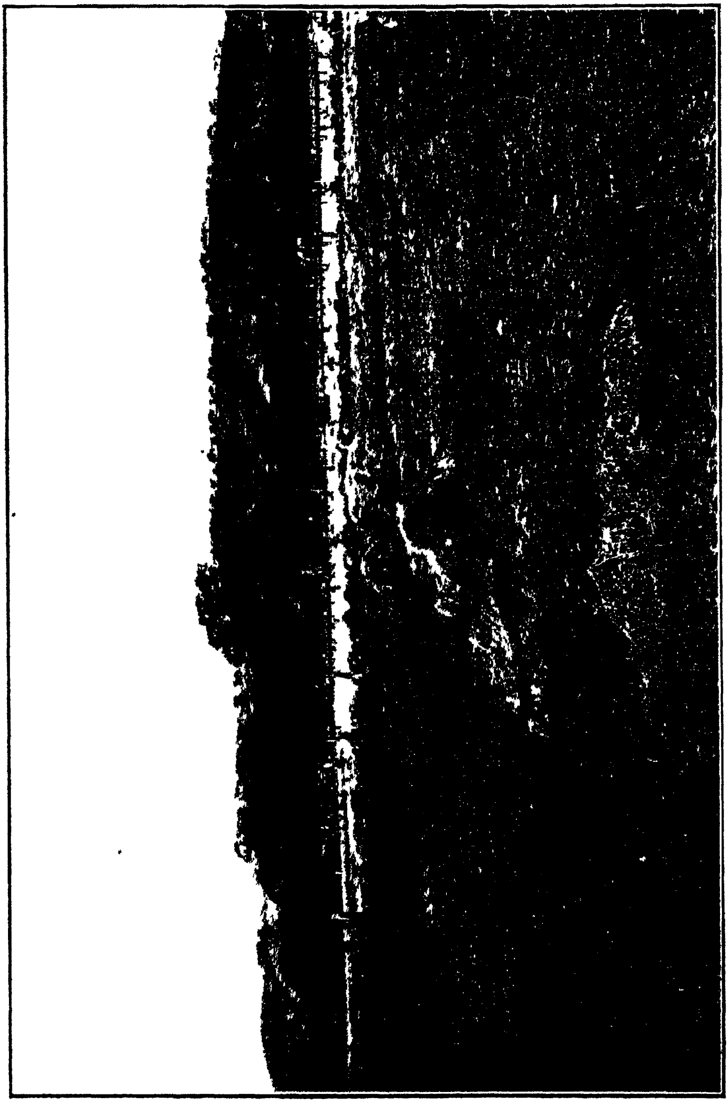

Group of large transported Stones, set in alluvium, looking East.

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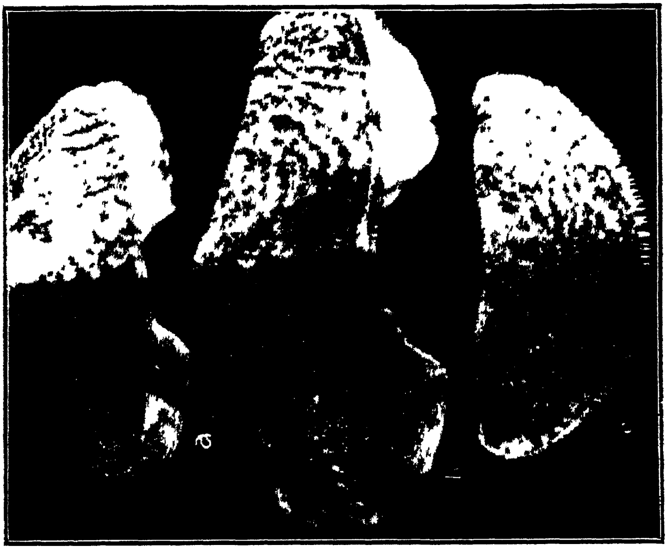

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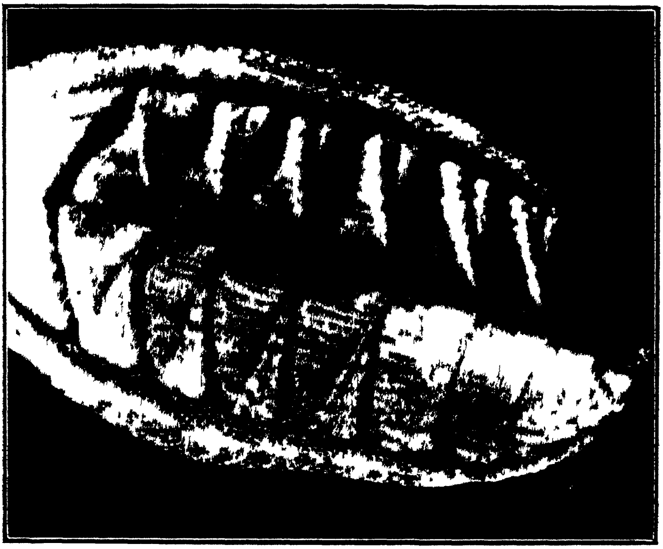

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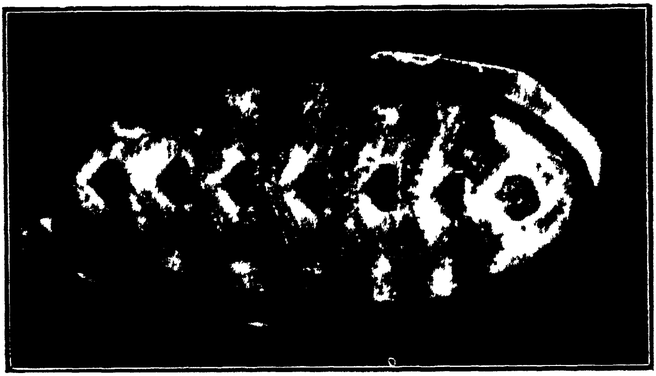

Fig. 3

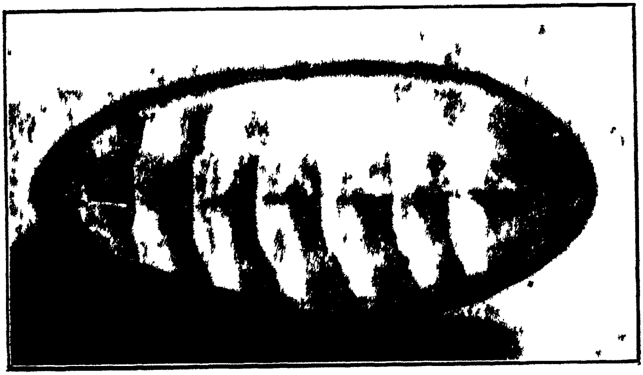

Fig. 2

Fig. 1

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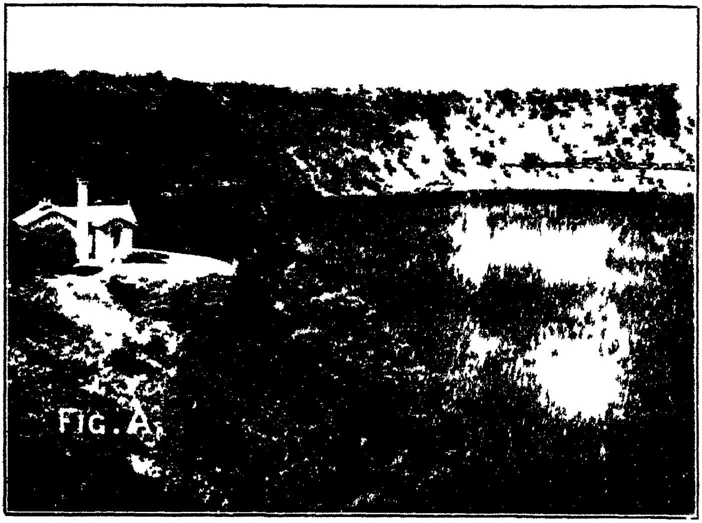

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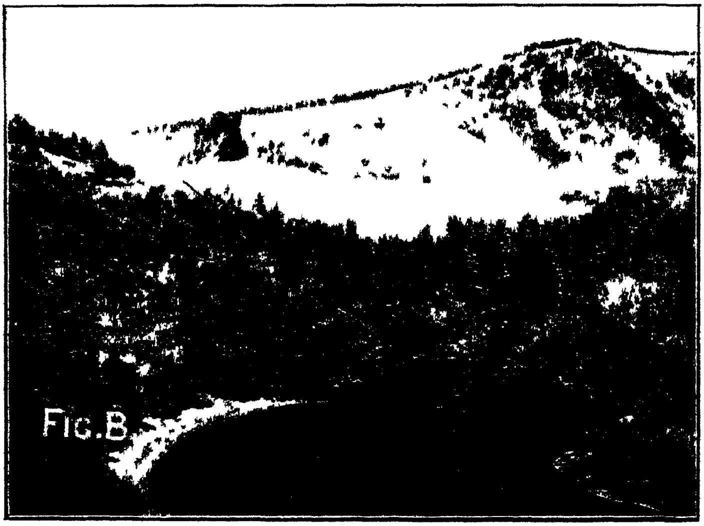

FIG. B.

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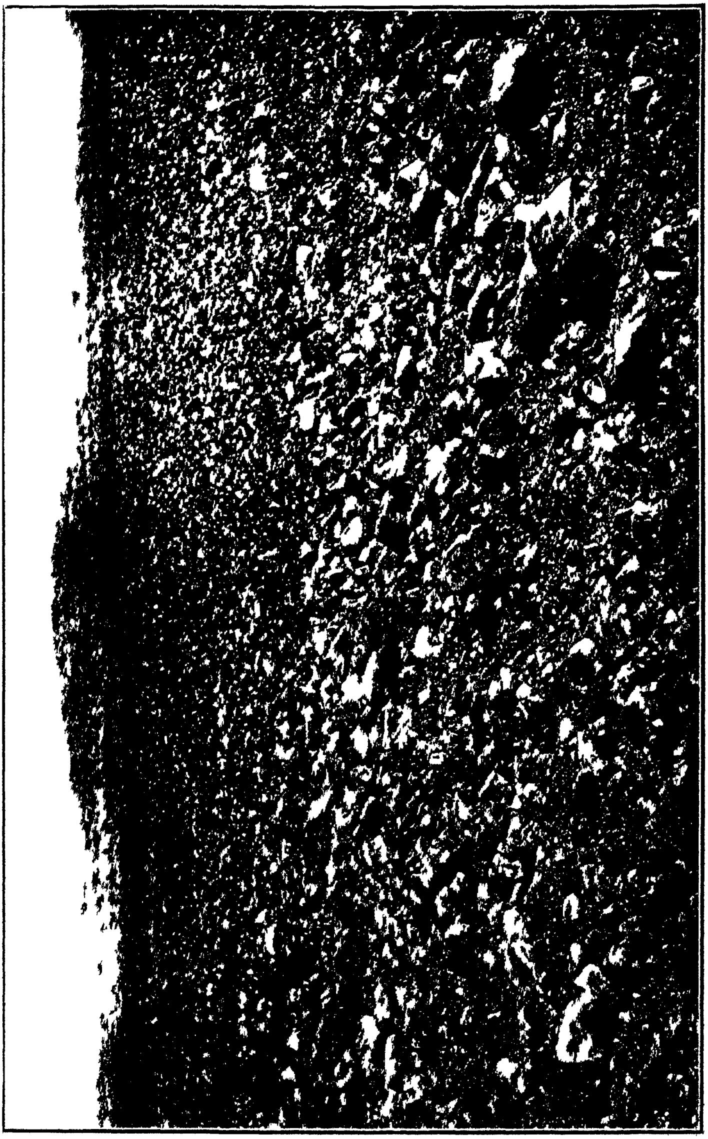

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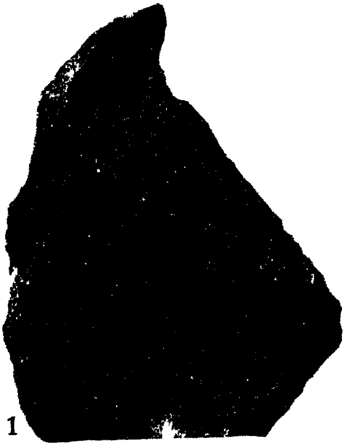

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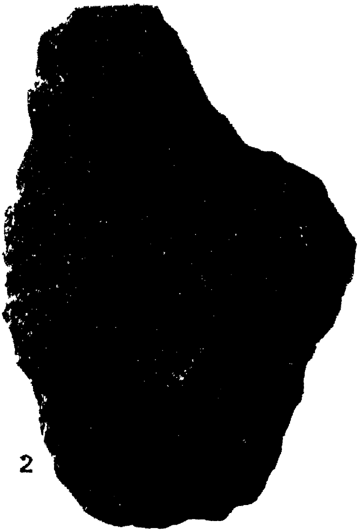

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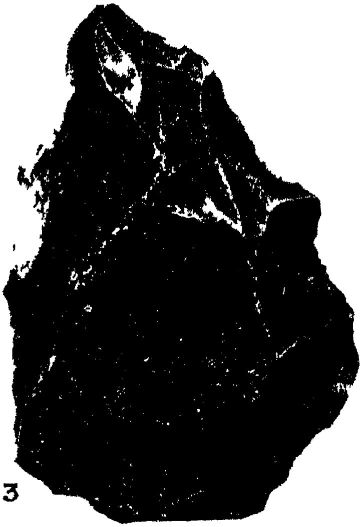

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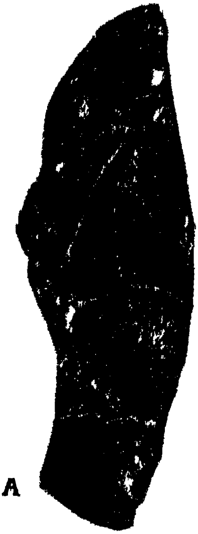

3A

Aboriginal Implements from the Tableland, Central Australia.

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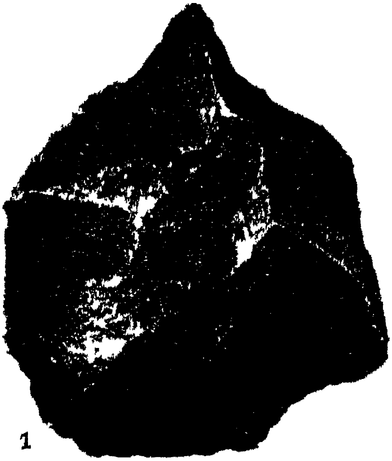

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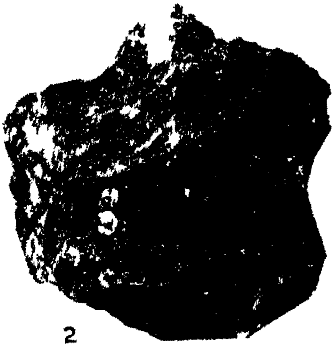

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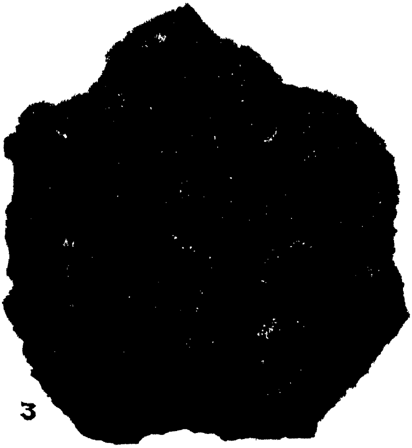

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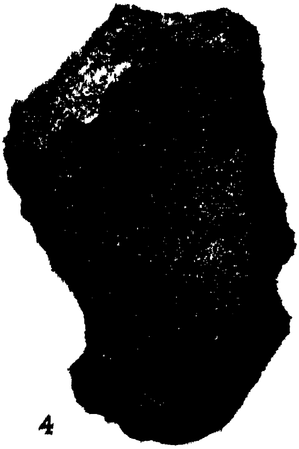

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Figs 1, 3, 4 Aboriginal Implements from the Tableland, Central Australia

Fig 2 Tasmanian Implement

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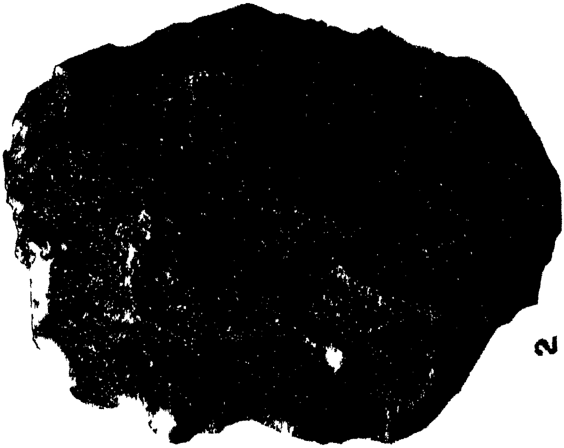

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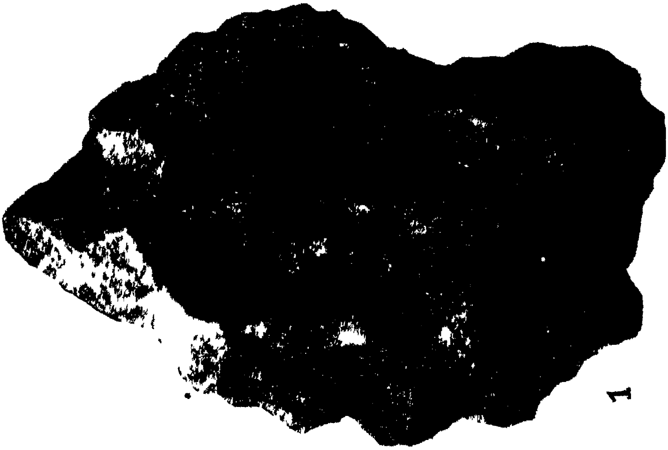

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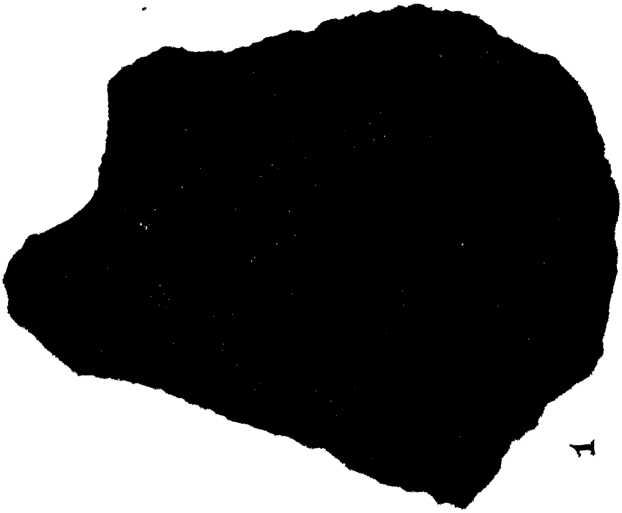

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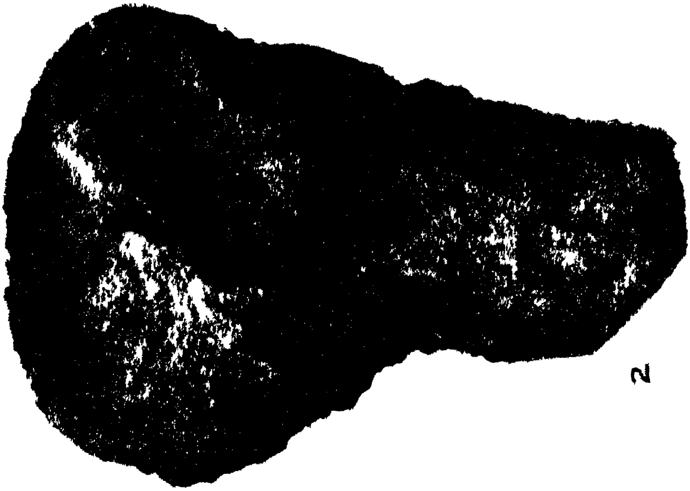

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Aboriginal Implement from the Tableland, Central Australia

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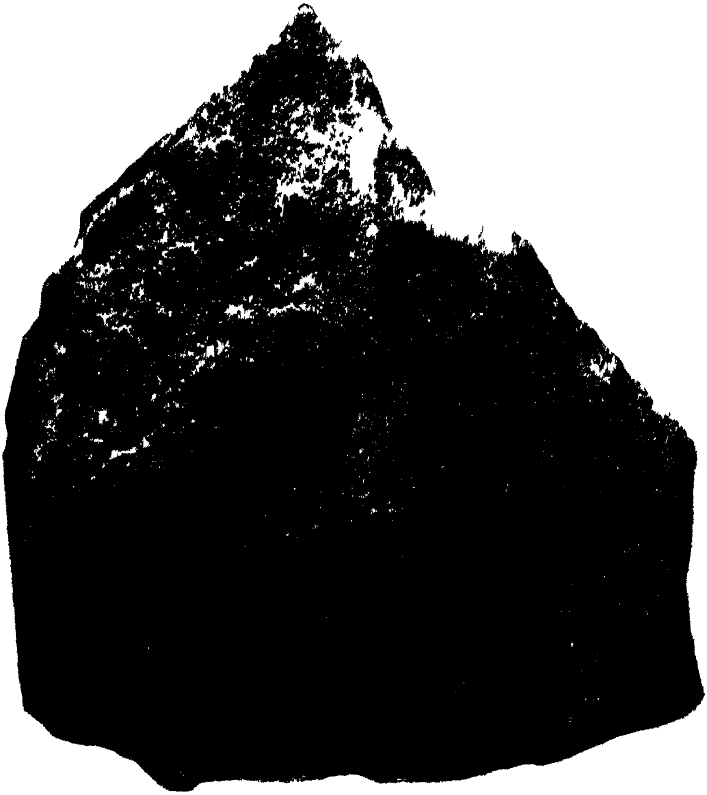

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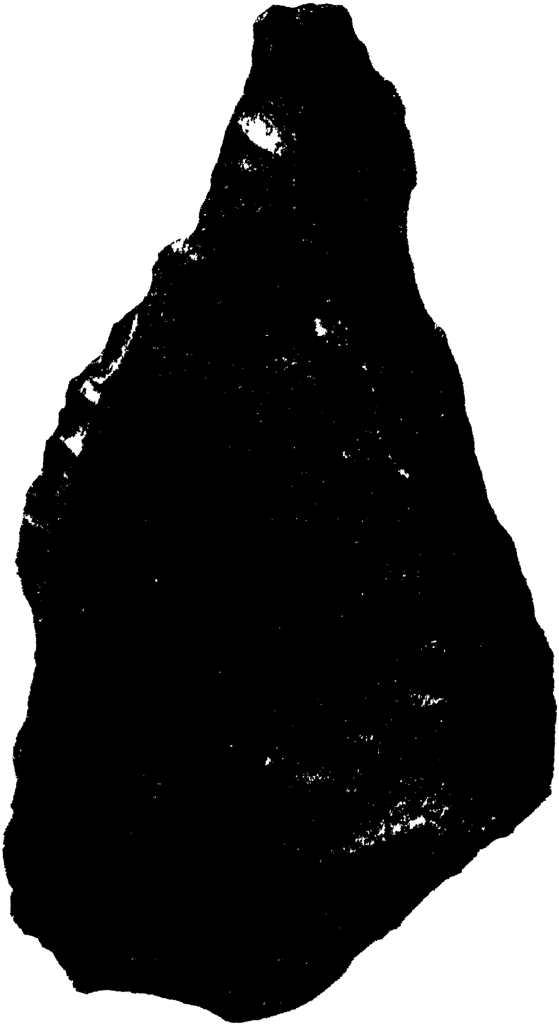

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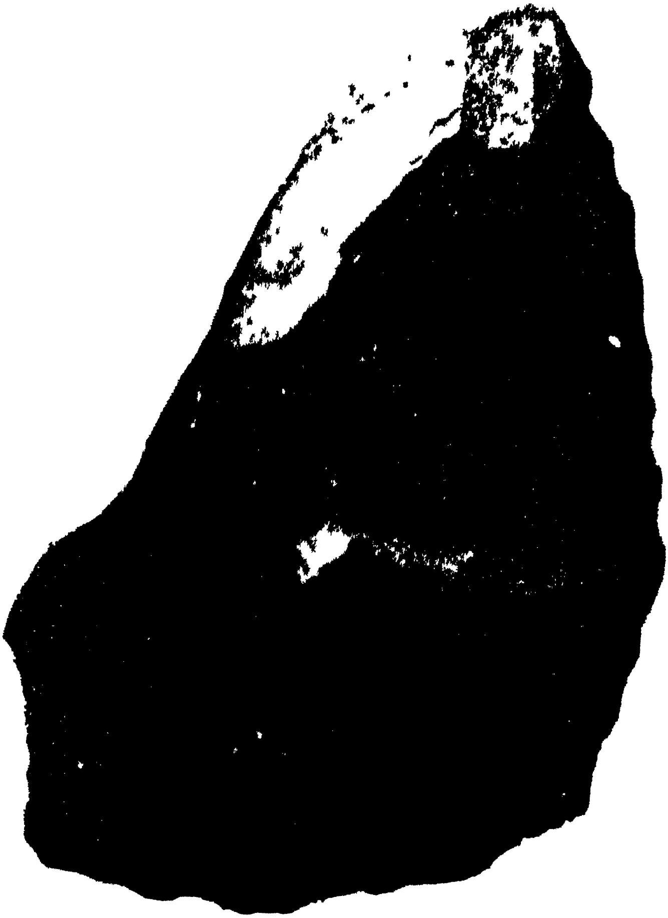

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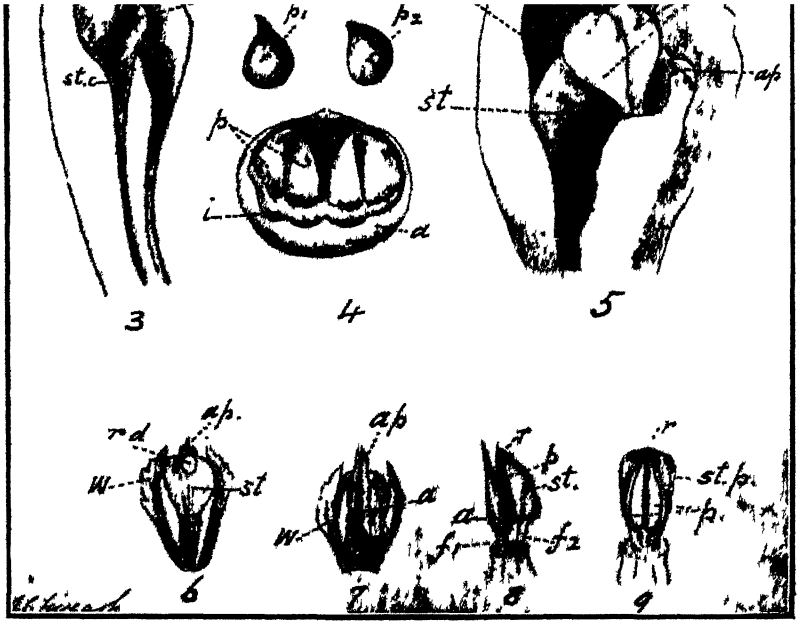

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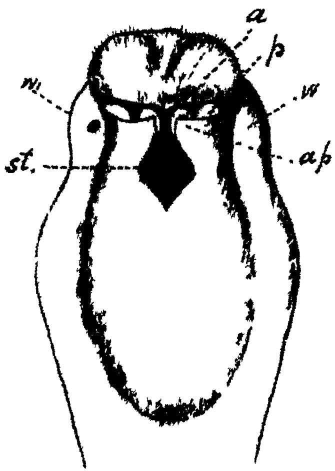

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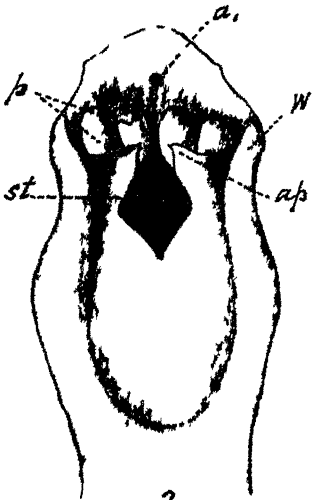

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OF THE

ROYAL SOCIETY of SOUTH AUSTRALIA

(INCORPORATED).

VOL. XLVI.

[WITH FORTY-TWO PLATES, AND SIXTY-SIX
FIGURES IN THE TEXT.]

EDITED BY PROFESSOR WALTER HOWCHIN, F.G.S.,
ASSISTED BY ARTHUR M. LEA, F.E.S.

PRICE, TWENTY-TWO SHILLINGS

Adelaide:
PUBLISHED BY THE SOCIETY, ROYAL SOCIETY ROOMS, NORTH TERRACE,
DECEMBER 22, 1922.

PRINTED BY GILLINGHAM, SWANN & CO., LTD., 106 AND 108, CURRIE
STREET, ADELAIDE, SOUTH AUSTRALIA.

Parcels for transmission to the Royal Society of South Australia from the United States of America can be forwarded through the Smithsonian Institution, Washington, D.C.

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THE
Transactions
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Vol. XLVI.

A NOTE ON THE PATHOLOGICAL MORPHOLOGY OF CINTRACTIA SPINIFICIS (LUDW.) MCALP.

By T. G. B. Osborn, D.Sc.,
Professor of Botany in the University of Adelaide.

[Read November 10, 1921.]

Plate I.

The fungus now known as *Cintractia spinificis* was described, in 1893, by Ludwig from material collected by Mr. J. G. O. Tepper, near Port Adelaide. In the original description the fungus, which was placed in the genus *Ustilago*, was stated to occur on the female inflorescences, destroying the ovaries.

In his monograph on "The Smuts of Australia" (1910) McAlpine redescribed the fungus, transferred it to the genus *Cintractia*, and gave an account of the method of spore formation and germination.

The purpose of this note is twofold—first, to place on record the presence of the fungus in the male inflorescences; and, second, to describe certain modifications of the host, occurring in both male and female inflorescences, due to the presence of the parasite.

Cintractia spinificis was first noted on the male inflorescences of *Spinifex hirsutus*, in February, 1918, at Wright Island, Encounter Bay. The season was then far advanced, and almost all of the spores were shed; there was, however, sufficient evidence to determine the fungus provisionally. In subsequent seasons—January, 1919 and 1920—it has been found in abundance at Victor Harbour, occurring on the male as frequently as on the female inflorescences. It has also been found at Grange, not far from the type locality in which

Tepper first collected it on the female. The smut is less conspicuous on the male inflorescences, nor is so large a spore mass formed, which may account for it being overlooked by previous collectors.

PATHOLOGICAL CHANGES IN THE HOST.

The inflorescences of the "spiny rolling grass" are common and conspicuous objects along the coastal dunes of South Australia. The salient features of the normal inflorescences will first be described, then the pathological changes noted.

The normal male inflorescence is a roughly spherical head, about 15 cms. in diameter, borne on a stout upright stem. It consists of an aggregation of stiff secondary axes, each arising in the axil of a bract, upon which the spikelets are borne. Below the terminal head there is usually one, sometimes two, smaller lateral clusters of secondary axes. Each secondary axis is a stout structure about 7 or 8 cms. long, bearing a group of 10 to 20 irregularly spirally arranged spikelets distributed over the middle third of its length. The upper and lower portions of the axis bear no spikelets, the upper part terminating in a stiff tapering spine. The spikelet is composed of two sterile glumes and two flowering glumes, or three sterile and one flowering glume. The flower consists of glume, pale, two broad lodicules, and three stamens. The axis of the flower ends abruptly with the stamens; no ovary rudiment has been seen in the flowers examined.

The smutted male inflorescences are much slenderer and more diffuse (pl. i., fig. 1). The main differences are:—

(a) Greater elongation of the internodes of the upright stem. In the smutted specimens the average length of internode between the terminal head and the small lateral cluster, next below it, was 9·4 cms. as against 6·7 cms. in healthy specimens.

(b) Reduction in the number of secondary axes bearing spikelets in the inflorescence; an average of 16 per head in the smutted specimens as against 64 in the healthy specimens.

(c) The closer aggregation of the spikelets and an increase in their number per secondary axis.

The smutted male spikelets consist of the two sterile glumes and two florets. Each has the fertile glume, pale, and three stamens. No lodicules were seen (text fig. 1), the anthers are about normal length, but contain no pollen, and the filaments do not elongate. No ovary recognizable as such is present, but the axis of the flower elongates above the point of stamen insertion, producing an irregular conical mass

1-7 mm. long. This, in the ripe smut gall, consists of a central core of host tissue coated by the spore mass, which is bounded externally by the usual white skin seen in Cintractias.

As is well known, the normal female inflorescence of *Spinifex hirsutus* is a large globular head, consisting of radiating spines, 40 cms., or even more, in diameter. This is borne, terminally, on a stout erect stem, and below it is one, or sometimes two, small lateral groups of secondary axes, bearing flowers. The head itself is not more than 4 or 5 cms. above the node below, and when ripe is readily detached by snapping off the axis at an absciss region immediately above the node. It then blows away, distributing the fruits as it breaks up. The head is a complicated system of secondary axes, arising in the axils of chaffy bracts, about 8 cms. long. The majority of these axes are long tapering spines, averaging 17 cms. (13·5-20 cms.), which are sterile. They are borne in groups of 6-12 or more, each group representing a branch system with exceedingly short internodes. These spines form the spring-like "legs" of the tumble weed, and are a most characteristic feature of the plant. In each group of sterile spines are a few (1-4) shorter and stouter spines, 10-12 cms. long (text fig. 2). These are the fertile secondary axes, each of which has a single spikelet at its extreme base. The spikelet consists of three sterile glumes (or two sterile and one abortive male flower) and one fertile glume. The flower has glume, pale, three stamens with minute anthers borne on filaments as long as the ripe grain, and an ovary.

The diseased female inflorescence is strikingly different from the normal (pl. i., fig. 2). The main differences are.—

(a) Elongation of the internode below the terminal head.

(b) Complete absence of the long sterile spines which are so obvious in the normal inflorescence. A few sterile spines may be present, but these are shorter than the fertile spines, of which the head is largely built up.

(c) The spikelets are borne 1·5-4 cms. above the base of the fertile secondary axes, which are half as long again as normal, *i.e.*, up to 15 cms.

The smutted female spikelet consists of two sterile glumes and two fertile. Both the florets are much modified by the fungus (text fig. 4), but the modifications are the same in each flower, *i.e.*, the lower floret, normally an abortive male, behaves like a female. The florets have glume and pale, both longer than usual, the latter being often involved in the smut gall. No stamens have been recognized, the whole of each floral axis above the pale being one elongate, rarely bifurcate, smutty mass (text fig. 5).

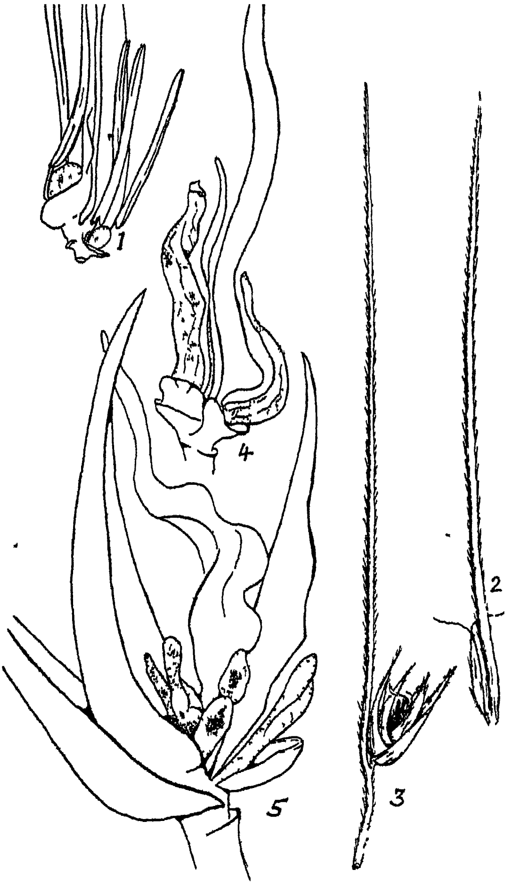

Fig. 1. Smutted male spikelet with two flowers; the glumes are all cut away. The stamens are sterile, the filaments do not elongate, but the anthers are not smutted. A central smut-body has formed (stippled). ×5.

Fig. 2. Normal female secondary axis, with spikelet at its extreme base. About natural size.

Fig. 3. Smutted female secondary axis, of greater length than normal, with the diseased spikelets 2 cms. above the base. About natural size.

Fig. 4. Smutted female spikelet with two flowers, the glumes all being cut away. The pales are left, that of the upper flower being smutted. Note the elongate smut mass that replaces the ovary (stippled). ×5.

Fig. 5. Smutted female spikelet as above. The lower sterile glume is removed and the lower fertile glume is partly cut away. The upper pale is hypertrophied and involved in the smut gall. The galled ovary of this flower is bifurcate. ×5.

GENERAL.

Various observations as to the effect of parasitic fungi upon the flowers of the host are summarized by von Tubeuf.(1)

Owing to the extent of gall formation induced by the fungus, it is not possible to say if ovaries are actually developed in male flowers of *Spinifex hirsutus* (*cf.* the cases cited by Tubeuf of *Carex praecox* with *U. caricis*, *Buchloe dactyloides* with *T. buchloeana*, and *Andropogon provincialis* with *U. andropogonis*). But in place of the normally abbreviated floral axis a more or less extensive smut gall is developed, resembling that formed in the female flower, except that in the male inflorescences it is usually somewhat smaller. A similar prolongation of the axis is seen in the axil of the third glume of the female spikelet. This glume, it will be remembered, is either sterile or subtends a male flower in the healthy inflorescence.

In a paper on *Tilletia foetens*, Barrus(2) cites observations by Edler, Appel, and Miczynski upon wheat affected by stinking smut to the effect that the diseased heads are looser than normal and of greater length, though Barrus' own observations showed that the infected heads were rather shorter. He notes that more grains are found in a smutted ear of wheat than in a normal one of equal length, there being more ovaries per spikelet in the former case. So in *Spinifex hirsutus* two smut masses form per female spikelet, though the healthy flower has but a single ovary.

The most obvious pathological deformation is the complete absence of the long sterile axes or spines of the normal female inflorescence. Thus the smutted head has not the same potentiality for distribution as the healthy one, for it cannot roll about in the same way. It was probably this feature that led to the earlier recognition of the fungus on the female plants. More interesting is the development of structures resembling those formed in female flowers upon the male, which, though they are not so definite as in the case of the smuts, referred to above, yet seem to merit brief description.

DESCRIPTION OF PLATE I.

Fig. 1. Male inflorescence of *Spinifex hirsutus* infected with *Cintractia spinificis*, showing the reduced number of spikelet-bearing axes and an increase in the number of spikelets above the normal.

Fig. 2. Female inflorescence of *S. hirsutus* with *C. spinificis*, showing the looser structure, the absence of long sterile spines. and the spikelets some 2 cms. above the base of the spikelet-bearing axes, abnormalities due to the presence of the fungus.

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(1) Tubeuf and Smith, "Diseases of Plants," 1897, pp. 26-29.

(2) Barrus, M. F., "Observations on the Pathological Morphology of Stinking Smut of Wheat," Phytopathology, vi., pp. 21-28, 1916.

OCCURRENCE OF REMAINS OF SMALL CRUSTACEA IN THE PROTEROZOIC (?) OR LOWER CAMBRIAN (?) ROCKS OF REYNELLA, NEAR ADELAIDE.

By PROFESSOR T. EDGEWORTH DAVID, K B E , C.M G , D.S O , B A , F R S., Hon D Sc Oxford and Manchester

[Read November 10, 1921.]

PLATE II.

DESCRIPTION OF FOSSILS.

Through the kind assistance of Professor Walter Howchin, F G.S., I was enabled, over a year ago, to examine some good sections of the siliceous limestones underlying the Brighton limestone, at Reynella, 17 miles southward of Adelaide. The siliceous limestone, as exposed in several of the small quarries belonging to the South Australian Portland Cement Company, and nearest to Reynella, on the left bank of the Field River, shows curious small ochreous bodies in a bluish-grey ground-mass. The limestone is mostly oolitic in structure. These yellowish-brown to ochreous bodies are seen under the microscope to be distinctly of organic origin, and there can be little doubt that they are referable to some kinds of minute crustacea. Their general appearance is shown on fig. 3 of pl. ii

The larger object shown on the left side of fig. 3, and about 2 mm. in length, has all the appearance of being a swimming paddle. The object marked *(f)* is possibly part of a spiral gill. The remainder of the objects in fig. 3 are probably locomotary appendages.

Fig. 2 probably represents a small carapace. Fig. 1 is the only specimen which shows some bilaterally symmetrical organization. At the top are traces of what may be antennae or antennules, followed below by two pairs of small processes, and below these is a pair of stouter appendages, probably claws The spiral object to the right of the claw (?) may be one of the spiral gills. A pair of possible parapodia follow, and then two fragments of what may have been a somite, or body ring. The remainder of the dark objects seen are quite problematical. Similar but less well-preserved objects occur in the overlying Brighton limestone.

GEOLOGICAL HORIZON.

The siliceous limestones of Reynella are about 2,500 ft., possibly more, below the base of the Cambrian limestones containing *Archaeocyathinae* at Sellick Hill, 35 miles southerly from Adelaide. The siliceous limestones of Reynella and the Brighton limestones, together with those of Burra (on the horizon of the Brighton limestones north of Adelaide) are singularly like those of the Nullagine series in Western Australia, and called by the Government Geologist (Mr. A. Gibb Maitland) the Carawine limestones The thick reddish-purple slate beds of the Adelaide region immediately above the Brighton limestone have a close analogy in the reddish-purple slates and shales of the Hamersley Range of the Fortescue River area of Western Australia and the reddish-purple slate series underlying the Irwin River coal measures (Greta coal measures), both occurring in the Nullagine series of Western Australia

The black shales, at least 1,500 ft. thick, which at Sellick Hill underlie the *Archaeocyathinae* limestones, and there contain small chalcedonic nodules, appear to correspond closely with the black shales with chalcedonic nodules at the top of the Nullagine series of Western Australia, as seen in the hills about 16 miles northerly from Roy Hill Station, on the Fortescue River. No fossils have, as yet, been found in the Nullagine series, and Mr. A. Gibb Maitland classifies them now as Proterozoic.

With the exception of some doubtful radiolaria, figured by Professor Howchin and myself from the horizon of these siliceous limestones near Hallett Cove,(1) and a problematical calcareous fossil found by Professor Howchin apparently weathered out of the purple slate beds near Hallett Cove, no organic remains have previously been recorded from these beds in South Australia. Mr. A. Gibb Maitland, as already stated, classes the Nullagine series as Proterozoic, while Professor Howchin classes these equivalents (in my opinion) of the Nullagine series of Western Australia as Lower Cambrian. I would tentatively suggest that all the strata from the base of the *Archaeocyathinae* limestones to the basal conglomerates overlying the Archaean (?) schistose rocks of Aldgate, in the Adelaide region, be given some local name such as "the Adelaide series," and, for the present, I would suggest that they may be classed, provisionally, as Proterozoic (?). It is quite possible that more than one series of rocks are included in the suggested Adelaide series.

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(1) Proc. Linn. Soc. N.S. Wales, 1896, pt. 4, pp. 571-583, pls. xxxix.-xl.

If the crustacean remains, referred to in this paper, are really, as I believe, Proterozoic in age, it would be of quite extraordinary interest to secure a complete fossil specimen. What appear to be casts of annelid burrows can be discerned in the weathered outcrops of those remarkable "varve" rocks, the Tapley Hill shales, near Adelaide, which occur several hundreds of feet below the Reynella horizon. There is, therefore, convenient to Adelaide, a considerable thickness of strata containing traces of obscure organisms, and it is to be hoped that patient search by local geological workers will soon be rewarded by the discovery of some complete specimens. Such a discovery would doubtless prove of priceless value to the palaeontologist.

DESCRIPTION OF PLATE II.

Remains of small Crustacea from the Proterozoic (?) or Lower Cambrian (?), Adelaide Series, Reynella, near Adelaide.

Fig. 1. Bilaterally symmetrical organism, probably Crustacean, showing antellules, claws, spiral gill, parapodia (?), etc.

Fig. 2. Probably a small carapace.

Fig. 3. Various small appendages, probably locomotary, but (t) may be portion of a spiral gill.

NOTES ON AUSTRALIAN POLYPLACOPHORA, WITH DESCRIPTIONS OF THREE NEW SPECIES AND TWO NEW VARIETIES.

By EDWIN ASHBY, F.L.S., M.B.O.U.

[Read April 13, 1922.]

PLATE III.

Genus ACANTHOCHITON (Gray, 1821, em.).

In our paper of October, 1898 (Trans. Roy. Soc. S. Austr.), and subsequent papers, Dr. Torr and the writer followed Dr. Pilsbry in adopting the name for this genus of *Acanthochites*, Risso, 1826.

In Proc. Mal. Soc., vol. xi., pt. ii., pp. 126 and 127, June, 1914, Mr. Tom Iredale draws attention to the fact that E. Gray's name of *Acanthochitona* (Lon. Med. Repos., vol. xv., 1821) antedates Risso's name by five years, and he therein also points out that in the name commonly used, Risso's spelling has been amended. Iredale followed this in July, 1915 (Trans. N. Z'd Inst., vol. xlvii., p. 422, 1914), by amending Gray's name in dropping the terminal "a" and writing the genus "*Acanthochiton* (Gray, 1821, em.)". It will also be seen that Dr. Pilsbry, *l.c.*, while adhering to Risso's name, gives "*Acanthochiton*, Herrmannsen, Indicis Generum Malacozoorum Primordia, i., p. 2; *Acanthochiton* of Carpenter and many modern authors." While several Australian workers have adopted Gray's name in place of Risso's, as pointed out by Iredale, *l.c.*, it is regrettable that they have not followed Iredale in the amended spelling, changing *Acanthochitona* into *Acanthochiton*.

In all my papers, in 1918 and since, I have adopted Iredale's spelling for the following reasons:—(1) The terminal "*Chiton*" is in keeping with so many other genera. (2) The two words, "*Acantho*" and "*Chiton*," are both masculine, and Gray seems to have tacked on to these two Greek words a Latin feminine terminal, thereby producing what my friend the classical professor terms, a "mongrel word." It is possible that Gray added the "a" to make his new genus agree with a certain specific name, a course that can hardly be justified; anyhow, I cannot see how we can do otherwise than adopt Iredale's suggestion and drop the unfortunate terminal. This course seems to be the commonsense one, and is probably the only correct one, and, as Iredale says, there are plenty of precedents.

ACANTHOCHITON (NOTOPLAX) GABRIELI, n. sp.

Differs from *A. costatus*, Ad. and Ang., in having deep, broken, longitudinal grooving in the dorsal area, whereas *A. costatus* has smooth, except for the transverse ribs following the lines of growth.

The pustules in the diagonal ribs of the species under description are larger, more rounded, and irregular than in *costatus,* and in addition on some of the valves there are evidences of a second coarsely pustulose rib on the posterior margin of the median valves, in this respect approaching its Western Australian ally, *A. sub-viridis,* Torr.

Remarks.—The specimen described above has been kindly lent to me for description in this paper by my friend Mr. Gatliff; it is from Caloundra, in Queensland, and the type, which has not been disarticulated, remains in Mr. Gatliff's collection. I am naming it after my friend Mr. Charles J. Gabriel, who has for so long been associated with Mr. Gatliff in the excellent conchological papers they have jointly produced. While I suspect this form should hold sub-specific rank only, it is as much entitled to the higher rank as are some of its allies referred to in the discussion following.

ACANTHOCHITON COSTATUS, Ad. and Ang., and its allies.

(Ad. and Ang., P.Z.S., 1864, p. 194; Angas, *l.c.*, 1867, p. 224.)

The examination of the preceding species from Caloundra and, subsequently, the loan of a specimen from Port Philip, Victoria, measuring 7½ mm. in length, by Mr. Gabriel, has made it necessary to go into the whole question of the respective relationships of several nearly-related species.

My series of *A. costatus* include three from Sydney, 6, 12, and 19 mm., respectively; several from Tasmania, up to 36 mm. in length; and one from South Australia, 21 mm. All have minute, slender, girdle spicules, easily detached; all have several ribs composed of coarse pustules, behind the mucro, in tail valve, but in the smallest this feature is represented only by a single large pustule at the outer edge; all probably, in the quite juvenile stage, possess none of those posterior ribs. In the larger specimens the original form of the dorsal area in the juvenile is not quite clear, but in the three from Sydney Harbour, 6, 12, and 19 mm. respectively (dry), it certainly commences with a prominent, broad, rounded beak, the area rapidly widening with sundry jags at each side, giving the pinnatifid character. On reaching a total length of the whole shell of 6 to 10 mm., the dorsal area may slightly contract or continue in two parallel lines, forming in the adult a narrow raised dorsal ridge. On collecting the small specimen at the Quarantine Station, Sydney, in 1918, I at first thought it a different species owing to its wide diverging dorsal area, but at last noted that it was only a juvenile character.

Mr. Gabriel's small shell from Port Philip, about 7½ mm., which I understand has been recorded as *A. rubrostratus*, Torr, is similar to the juvenile *costatus* in having small spicules clothing the girdle and in having the broad dorsal area of the juvenile, but it differs in not having coarse pustulose ribbing behind the mucro and in the pustules of the diagonal ribs being small; in these two respects only does it resemble *rubrostratus* and *speciosus*. I believe that had it attained a larger growth it would have been quite similar to typical *costatus* in these respects It may be that in Victoria a race of *costatus* is living that attains the senile characters at a later age than is common to that species.

Throughout this paper all measurements given are of dry specimens. I have two specimens collected by myself in Gulf St. Vincent, measuring 8 and 18 mm. long, and I have compared them with Dr. Torr's type and co-type of *A. rubrostratus*, and find them con-specific; the girdle is covered with coarse white spicules, similar in size to those clothing the girdle of *A. speciosus*, H. Adams, but appear less irregular in their attachments and show between the valves in a much less degree; the dorsal area is similar in the two, except that the pinnatifid character is more continuous in *rubrostratus;* neither have ribs behind the mucro, although one of Dr. Torr's latter shows three waves or undulations corresponding with the posterior ribbing of *costatus*, nor have either the coarse pustules of that species in the diagonal ribs. The width of the girdle of *rubrostratus* is less than that of *speciosus*, and the beak of *speciosus* is less pronounced, but when it is considered that the whole of our specimens of *rubrostratus* are smaller than the smallest of our specimens of the other species, is it not possible that the slight differences enumerated may be due to the juvenility, and that *rubrostratus* is really the young of *A. speciosus*.

In conclusion.—As before mentioned, I have been much indebted to Dr. Torr for the opportunity of examining specimens in his collection, but until a much larger series of all the species, in all stages of growth, is available, I do not like to make a final decision, but I am inclined to think that ultimately we shall be able to recognize *A. costatus* as the dominant species, with two sub-species—*gabrieli*, Ashby, from Queensland, and *sub-viridis*, Torr, from Western Australia—*A. costatus*, sub-species, being found in New South Wales, Victoria, Tasmania, and South Australia; *A. speciosus*,

H. Adams, as a dominant species with *rubrostratus*, Torr, either as a sub-species or as a synonym, being the name distinguishing the juvenile form.

It should be mentioned that some of the forms above referred to show sub-cutaneous lining and others short longitudinal rows of shallow holes near the beak on the dorsal area. The following *resumé* may be helpful:—

Minute, slender, girdle spicules: *gabrieli, costatus, sub-viridis.*

Coarse, girdle spicules: *speciosus, rubrostratus.*

Broad, pinnatifid, dorsal area in juvenile: *gabrieli* and *costatus.*

Narrow, pinnatifid, dorsal area: *speciosus, rubrostratus, sub-viridis.*

Small pustules and no ribs behind mucro: *speciosus* and *rubrostratus.*

ACANTHOCHITON MAYI, n. sp.

Introduction.—A number of median valves of a rather striking *Acanthochiton* were dredged by Mr. W. L. May in various parts of Tasmania, in depths varying from 60 fms. to 100 fms. It is'such a distinct species and the valves are so well preserved that one seems well justified in describing it without waiting for the discovery of the whole shell. I have much pleasure in calling it after Mr. W. L. May, the discoverer, and a gentleman who has done such splendid work in conchology.

Specimen No. 1. Type.

Median valve.—Colour pale cream, very strongly carinated, prominently beaked, dorsal area well defined, fairly broad but sides almost parallel, *i.e.*, after attaining half-growth the sides of this area do not diverge. The central ridge and the two sides of this area continue as smooth ribs the whole length of the valve; the space between is cut up by short, deep, longitudinal grooves, reminding one of cuneiform characters. These deep grooves make the ribs, before referred to, jagged at their margins. The lateral area is separated from the pleural by a fold surmounted by extra large pustules, which are widely spaced. The first three rows next the beak are composed of minute pustules which quickly lose themselves in the lateral rib of the dorsal area, before referred to; the fourth row of pustules is composed of three minute and six large ones placed diagonally in the row which is parallel to the dorsal area, beyond the ninth pustule. In this row the sculpture is confluent, forming a broad flat rib for about one-third of the total length of the valve. The rest of the valve is decorated with five rows and one-half row of elongated, much-raised, flat pustules, widely spaced, and the rows widely separated from one another. All pustules are placed on the diagonal, and the rows themselves become more and more diagonal as the margin of the shell is approached. Slit 11 modified into a deep groove, with raised edges on the upper side of the articulamentum.

Measurements.—3 mm. longitudinally, 3·75 mm. laterally.

Habitat.—A number of valves dredged 7 miles east of Cape Pillar, North-west Tasmania, in 100 fms.; one valve, about the same depth off Schouten Island; one valve, coloured red, off Port Arthur, South-east Tasmania, in 60 fms.

Specimen No. 2. Co-type.

This median valve was likewise dredged in the same depth east of Cape Pillar. While corresponding, in the main, with the preceding valve, it differs in that the dorsal area is uniformly covered with short, deep, wedge-shaped, longitudinal grooves. Also the fold separating the pleural from the lateral area is very strongly raised, and the pustules in the rows, where they pass over this fold, are larger and broader than anywhere else, for a width of two pustules. If these pustules had not been so widely spaced one would have described the valve as possessing a wide diagonal rib composed of two rows of pustules. In method of sculpture and shape of the pustules the two valves described are otherwise identical.

In conclusion.—The type is being presented to the Tasmanian Museum and is figured from a drawing. The co-type is figured from a photograph taken by the writer and remains in my own collection. In a paper on Polyplacophora of Tasmania, by W. L. May and Dr. Torr (Proc. Roy. Soc. Tas., 1912, p. 35), a note is made that the valves described above were wrongly identified by Hedley and May (Rec. Austr. Mus., vol. vii., No. W, 1908) as *Acanthochiton crocodilus*, Torr and Ashby.

ACANTHOCHITON SHIRLEYI, n. sp.

Specimen No. 1. Type

General appearance.—Broad, girdle wide, densely and coarsely spiculose, shell flat and low, the spicules of the girdle standing up above the shell.

Colour.—Some valves are darkhorn-colour, others are creamy-white; the dorsal area is creamy-white in some valves.

Anterior valve.—I cannot notice any rays or undulations. The sculpture on this valve is largely eroded, but it is evidently well covered with circular pustules. Insertion plate long, slits 5, notch very short but continued on upper side in a broad groove to the tegmentum, colour white tinged with blue. Measures 3½ × 3½ mm.

Posterior valve.—Tegmentum very small, about two-fifths of total width of valve, anterior portion semi-circular, mucro posterior, dorsal area rather narrow, wedge-shaped, rugose; the wrinkles following the growth-lines are continued across the anterior portion of the dorsal area. The shell behind the mucro is very flat, and shows little sculpture; such as there is, is composed of shallow broken wrinkles following the growth-lines. The dorsal area and the portion behind the mucro creamy-white, side areas dark horn and sculptured with rows of irregular, flat, more or less circular pustules, following the growth-lines and, in places, especially towards the outer margin, coalescing. Insertion plate long and very broad, slit 11, sutural laminae small and produced forward with a deep inward bent between them and the wings of the insertion plates. This feature is very marked. *A. bednalli* has a somewhat similar inward fold at the slits, but this species has this fold on the opposite side of the wing of the insertion plate. Sinus broad, the semi-circular margin of the tegmentum only occupies half the width. Colour of articulamentum, pale bluish; the slits are continued half-way to the tegmentum in a deep, almost semi-circular groove. This valve measures, longitudinally 3 mm., laterally 4½ mm

Median valve.—The following is a description of valve 4:—The dorsal area is smooth except for growth-wrinkles which are continued from the side areas; this area consists of a shallow wedge-shaped depression (this feature is common to all valves except valve 2, in which this area is arched; a similar variation occurs in a second specimen described hereunder), some of the growth-wrinkles are in this area broken, suggesting an ill-defined string of granules. The lateral and pleural areas are not separated but are studded with rows of flat circular pustules, following the growth-lines. The slope of the sides below the elevated fold that margins the dorsal area is slightly curved. Inside, as well as the insertion plates and sutural laminae, pale blue, slits 11, sutural laminae produced forward, sinus narrow and rounded. This valve measures 4½ × 4½ mm.

Girdle.—Densely covered with long, coarse, cream-coloured spicules; the fringe spicules are a little more slender; sutural tufts long, porcelain-white, and pointed.

Measurement of dried shell, 15 × 6 mm.

Habitat.—North-west Reef, Barrier Reef, Queensland.

Remarks.—I am indebted to Dr. John Shirley for the opportunity of examining and describing this *Acanthochiton*, and I have much pleasure in naming it after him. The specimens submitted to me were badly encrusted and, in parts, eroded, the true characters only became visible on disarticulation and cleaning. The shape of the articulamentum both in median and tail valves, the fact that the dorsal area is usually concave, and the girdle densely spiculose, easily separates this *Acanthochiton* from any other Australian species. The type belongs to the Queensland Museum.

Specimen No. 2. Co-type.

The second specimen, which I am calling the co-type, differs from the type in that the centre of the dorsal area, in the median valves, is slightly convex, becoming flat or slightly concave before the pustulose sculpture is reached. Also the pustulose character of the sculpture is more limited in area, anteriorly the pustules, which are very flat, become subobsolete and confluent following the course of the growth-lines The co-type remains in my collection.

ACANTHOCHITON RETROJECTUS, Pilsbry,
var. *pustulosus*, n. var.

(A retrojectus, Pils., Naut., vii., p. 107, Jan., 1894; Proc Acad. Nat. Sci. of Phil., 1894.)

Introduction.—In November, 1918, I collected a very long series of *A. retrojectus,* Pilsbry, in the Quarantine Station, Sydney Harbour. And early in 1919 the following notes on this somewhat difficult species were written. At first one concluded that there were at least two or three different species represented in the series collected from the one spot. Many had similar sculpture in the dorsal area to that of the other areas, but in some this area was smooth, and, again, while many had the regular, evenly-rounded, pustulose sculpture described by Dr. Pilsbry, in others a large part of the shell was ornamented with large tear-drop pustules.

On fuller investigation it was found that there was a complete series of intermediate forms. All are similar in the character and structure of the girdle, the shape and lamination and slitting of valves, the tail valve and position of mucro; throughout these features seem consistent, and the extreme divergence of sculpture does not, in my opinion, warrant the separating of them into distinct species. Nevertheless, at the suggestion of my friend, Mr. W. L. May, I propose a distinct varietal name for the form with coarse pustules, calling it var. *pustulosus*.

Girdle is densely covered with minute scales or short blunt-ended spicules, these are mottled, the white ones often placed in rings, ×65; this ring resolves itself into a string of blunt-ended scales, set in a circle. Owing to the minute nature of these scales the general appearance of the girdle, except under a high power, is spongy. The sutural tufts are white and well defined.

Dorsal area.—Broadly wedge-shaped. In typical shells it is ornamented with longitudinal rows of strongly-raised circular pustules, set bilaterally in divergent lines, thus forming a V with the apex in the centre of the area. But in different specimens these pustules vary from circular, well-raised pustules to those that are mitre-shaped, or even to long flat dashes. Again, in some specimens this area is absolutely smooth except in the margins, but this variation appears somewhat rare.

Pleural and lateral areas.—These, in typical specimens, are not distinctly differentiated and are ornamented with longitudinal rows of strongly-raised circular pustules, gradually increasing in size towards the girdle. The varient, which I suggest should be known as variety *pustulosus*, Ashby, has the first row or so of pustules from the dorsal area, more or less round, but fully half the valve is decorated with a few large tear-drop-shaped pustules, some of them being fully three or four times as long as wide. In some, the regularity of the longitudinal rows is preserved; in others, this system of sculpture is lost, these tear-drop pustules being irregularly placed, widely separated, and very raised.

Colour.—While most specimens are mottled pale green and black, there are some that are pale green throughout, and others that are uniformly rufous; in some the dorsal area only is reddish-brown, in others it is pink. When disarticulated and cleaned the shells are transparent and, usually, both tegmentum and articulamentum are green.

Habitat.—While very numerous at Port Jackson, New South Wales, it appears less common in Victoria, and I have not taken it in South Australia, where its place is taken by the allied form, *A. kimberi*, Torr. This latter I also met with in Western Australia.

Probably the Sydney shell has extended down the east coast and then turned towards the west, along the Victorian coast; the allied form, *A. kimberi*, has come in from the west and somewhat overlaps *A. retrojectus* in Victoria.

I am indebted to Messrs. Gatliff and Gabriel for the opportunity of examining a number of specimens from their respective collections.

They were from Western Port, Port Philip Head, Point Nepean, Torquay, and San Remo, all in Victoria. They show a good deal of variation, mostly of the large pustulose variety. Some of the shells were larger than any I secured at Port Jackson, and amongst them were certainly some representatives of *A. kimberi.* Some forms of *A. retrojectus* are very difficult to separate from that species, unless the specimens are very perfect.

In conclusion.—Dr. Pilsbry, *l.c.*, founded the sub-genus *Meturoplax* for the reception of this species, chiefly on the character of the dorsal area, "dorsal area indistinctly differentiated"; while, in typical specimens, this may be true, this feature is not constant, and makes one hesitate to adopt his sub-generic name at this stage.

ACANTHOCHITON CORNUTUS, Torr and Ashby, and A. EXILIS, Torr and Ashby.

(Trans. Roy. Soc. S. Austr., vol. xxii., pp. 217-219, Oct., 1898.)

Until last year *A. cornutus* was only known from the unique type taken by the writer at Marino, in South Australia; but on January 24, 1920, I took a second at Cape Jervis. Messrs. Gatliff and Gabriel each lent me a very fine specimen that they had identified as *A. exilis.* I noted that they were con-specific with my type of *A. cornutus,* and, later, compared them with the type of *A. exilis* which is in Dr. Torr's collection, and found that *A. exilis* is simply the juvenile form of *cornutus.* I find a note in my note-book, made a couple of years back, that these two forms were very close to one another.

The largest specimen of the series dredged by Dr. (now Sir) Joseph Verco was selected as the type of *exilis,* and was only 3 mm. long; all the specimens were much curled and somewhat bleached, whereas the type of *cornutus* was over 10 mm. long and well preserved.

There are slight differences between the two, but not more than can be attributed to immaturity; the minute curled *exilis* certainly looked very different from the fine specimen of *cornutus,* but they are undoubtedly the same species. As *cornutus* was described on an earlier page than *exilis,* it has that priority, and *A. exilis* is a synonym thereof.

In the addendum to our paper, *l.c.*, reference is made to apparent "eyes" on the dorsal area of *A. cornutus.* It is interesting to note that small black specks are visible in the shells of the three recently discovered specimens, before referred to; but I have not yet been able to determine whether they are true eyes, or some other sense organ. The determination of their true character must be left to future investigation.

ACANTHOCHITON COXI, Pilsbry.

(Naut., vii., p. 119, Feb., 1894; Proc. Acad. Nat. Sci. Phil., 1894, p. 80, pl. iii., figs. 21-26, pl. iv., fig. 34; *A. lachrymosa*, May and Torr, P. and Proc. Roy. Soc. Tas., 1912, pp. 36 and 37, pl. i., figs. 1-4.)

The identification of this *Acanthochiton* has always been a difficulty with me. In July, 1919, I wrote the Australian Museum for the loan of a specimen, and at their suggestion Mr. Bassett Hull very kindly sent me a shell which, on examination, I found could not possibly be *A. coxi;* but, strangely enough, it was a worn specimen of a species described by Dr. Torr and the writer in October, 1898, under the name of *A. crocodilus*, and which, up till the identification of Mr. Hull's specimen from New South Wales, was only known to occur in South Australia, and limited to the pair originally described, which were side by side on the same rock, at low water, at Marino.

Later on I received specimens from Dr. Torr's collection and the Queensland Museum, labelled *A. coxi*, but in both cases they were misidentifications and referable to well-known species. Through some oversight, although I again applied to the Australian Museum for the loan of their co-type, it was never sent for my inspection.

In correspondence with Professor Dr. J. Thiele, of Berlin, I mentioned my desire to see *coxi*, and he was good enough to send me a specimen from Balmoral, which I conclude is the place of that name in North Borneo. The specimen was marked "identification uncertain." If it had come from Tasmania one would have no hesitation in identifying it as a slight variant of *A. lachrymosa*, May and Torr.

It differs from the Tasmanian shells, slightly, in the arrangement of the pustules, and the spicules on the girdle are slightly coarser. On writing Mr. W. L. May he advised me that he had some years ago seen the co-type of *coxi* in the Australian Museum and had made a note that it was very close to *lachrymosa*. In October last, Mr. May brought over a very fine series of *lachrymosa* from the type locality. We found that the sculpture varied from long, slender, flat, finger-like processes to short oval discs, or elongated tear-drop pustules. Most in the juvenile stage have quite small pustules, but even in this they are not consistent. They also vary very much in the spacing of the pustules; mostly they are crowded, as is so well shown in the figures accompanying May and Torr's description, *l.c.*

A comparison of these figures with the figures in Dr. Pilsbry's paper on "Port Jackson Chitons," *l.c.*, will explain the difficulty we have all laboured under in identifying *A.*

coxi, Pilsbry. The description in Pilsbry's paper would do for *lachrymosa*.

In conclusion.—While all previous records of *A. lachrymosa* have been confined to about 150 yards of beach, on Frederick Henry Bay, southern Tasmania, the writer was able some time ago to extend its range to Sulphur Creek, north-western Tasmania; and, more recently, Mr. May has found it on Bruny Island, and now Mr. May and myself are satisfied that it is con-specific with *A. coxi*, Pilsbry. We have the record of two specimens taken by the late Dr. Cox, at Port Hacking, New South Wales, and, finally, Dr. Thiele's specimen extends its range far into the tropics.

Thus a species that has hitherto been considered one of the most restricted in its range is found to have a most extended range north and south, probably greater than any other of our known specimens. It certainly appears very local in its occurrence, the reasons for which must await further elucidation. I have sent two specimens to Dr. Pilsbry, asking him to kindly compare with his type of *A. coxi*, and advise whether he can find any justification for retaining the Tasmanian shell as a sub-species of *A. coxi*, Pilsbry.

Note.—Since the foregoing was written I have received Dr. Pilsbry's reply, which is as follows:—"I have carefully compared the specimens of *A. lachrymosa*, May and Torr, with the type of *A. coxi*. I am satisfied that there is no specific difference. A sub-specific difference may be indicated by (1) the difference in colour, my form being pink within, yours greenish; (2) the wider central areas of valves 3-8 in my specimen. This is exaggerated in the figures, which were done on stone by a commercial lithographer from my pencil drawings."

This fully confirms our opinion, and in face of the variability of this species we are hardly justified in making a sub-species of the southern form. *A. lachrymosa*, May and Torr, is therefore a synonym of *A. coxi*, Pilsbry.

The pitting of Callochiton platessa, Gould, var. *fossa*, nov.

(Proc. Bost. Soc. N.H., ii., 1846, p. 143.)

Some years ago I noted that one of the shells belonging to this species, that I had collected in Gulf St. Vincent, showed six deep pits, immediately in front of the lateral area of the seventh valve. On January 24, 1920, I collected a second specimen in which the same valve shows a similar number of pits. A few months back, when going through the collection of the Polyplacophora in the South Australian Museum, with a view to determining the species, I noticed a similar specimen with pitting confined to the same valve; all these were taken in this State. In going through a score of specimens in my own collection from New South Wales, Tasmania, South Australia, Western Australia, and New Zealand, with the exception of one specimen 25 mm. long from Sydney, which is pitted in the seventh valve, all are typical unpitted shells. Mr. W. L. May has sent me for examination three large and handsome specimens from Watson Bay, New South Wales, all of which show similar pitting on the seventh and eighth valves, and the largest one, which is over 40 mm. long, has incipient pitting in the sixth valve as well. In this specimen I counted 12 pits in the seventh valve. These pits commence high on the ridge in the juvenile shell. The pits are deep and only a little longer than broad, in fact very similar to the pits near the ridge of *Rhyssoplax oruktos*, Maughan, but there the likeness ends—they are not as regular in shape nor developed to the same length as in that species. Again, the character of the pitting is quite different from *C rufus*, Ashby. I have compared it with the type and with the juvenile form from the Bracebridge Wilson collection; the grooving of *rufus* can hardly be termed pitting, but is really longitudinal grooving, and is present to an equal extent in all the valves except the first.

In conclusion.—The existence of these pits and their occurrence consistently on the seventh valve, and in the case of the Watson Bay specimens on the eighth valve as well, suggests a definite tendency to vary in this direction. At first I thought of suggesting that deep-water specimens may have a greater tendency to develop this form of sculpture, and that *C. rufus* (which is only known from dredge specimens) may have been derived from such a pitted race of *C. platessa*. On more careful examination, however, I do not feel justified in advancing such a hypothesis It will be well worth while for collectors to keep their eyes open for this variant, which may well be known as *Callochiton plutessa*, var *fossa*, Ashby.

SYPHAROCHITON PELLIS-SERPENTIS, Quoy and Gaimard, 1835.

(*Chiton pellis-serpentis*, Quoy and G. Voy. Astrol., ii , 381, pl. 74, f. 17-22; Man. Conch. (1), xiv., 173, pl. 37, f. 11-17; Proc. Mal. Soc., ii., 195, c. *Squamosus*, L. Wissel, Zool. Jahrb., xx., 619, not of Linne (Anatomy); Tate and May, Proc Linn. Soc. N.S. Wales, 1901, pt. 3, pp. 412-415; May and Torr, P. and Proc. Roy. Soc. Tas , 1912, pp. 38 and 39. Type, Mus. Hist., Paris.)

SYPHAROCHITON SINCLAIRI, Gray, 1843.

(Dief., N. Z'd, ii., 263; Man. Conch. (1), xiv., 174, pl. 36, f. 1-3; Proc Mal. Soc., ii., 196; Wissel, Zool. Jahrb., xx., 627, pl. 23, f. 38-44, pl. 24, f. 45-48 (Anatomy). Type, Brit. Mus.)

SYPHAROCHITON MAUGEANUS, Iredale and May.
(Proc. Mal. Soc., vol. xii., pts. ii. and iii., p. 114-115, Nov., 1916.)

In October, 1921, Mr. W. L. May, of Tasmania, and the writer jointly examined a fairly large series we had collected in different parts of Tasmania with shells in my collection from New South Wales and New Zealand. My New Zealand specimens were from various localities, but the *S. sinclairi*, Gray, were from Doubtless Bay, collected by Mr. Albert E. Brookes, and from Te Onepote, collected by the late Mr. Suter.

We cannot agree with Iredale and May in separating the Tasmanian shells from the New Zealand ones, or from those from New South Wales. Pilsbry, in his paper on "Port Jackson Chitons" (1894), also states that he "was unable to detect any difference between New South Wales and New Zealand shells." Therefore *S. maugeanus*, Ire. and May, becomes a synonym of *S. pellis-serpentis*, Quoy and Gaimard.

Further, we find that the smooth shells living in company with the more sculptured ones, in Frederick Henry Bay, Tasmania, are con-specific with *S. sinclairi*, Gray, 1843, the New Zealand shells being similar to the Tasmanian ones. In both *S. pellis-serpentis* varies from the somewhat flat highly-sculptured shells so common in Port Jackson, New South Wales, to those that are almost smooth in all areas. We therefore consider that *S. sinclairi* is a smooth variant of *S. pellis-serpentis*, and is certainly common to New Zealand and Tasmania, and, on the authority of the late Dr. Cox, we must conclude, of New South Wales as well, although neither Mr. May nor the writer has seen the smooth variety from New South Wales.

Mr. May sends me the following note in reference to the foregoing:—"I agree with all you have written. The shell varies very much in height, some being very flat, others high and round backed, with all grades between; they also vary greatly in size in different localities. My largest, from Wedge Bay, is 56 mm. long; they may be almost white, black, or of varying patterns of black and white, etc."

In conclusion.—We find that *Sypharochiton pellis-serpentis*, Quoy and Gaimard, is an extremely variable shell in Tasmania, New Zealand, and New South Wales, varying from a highly-sculptured form to an almost smooth one, which must be known as variety *sinclairi*, Gray, the intermediates still living; and Iredale and May's *S. maugeanus* is a synonym of *S. pellis-serpentis*, Quoy and Gaimard.

LORICELLA ANGASI, H. Adams and Angas.
(Proc. Zool. Soc., 1864, p. 193.)

In my paper on the above genus (Trans. Roy. Soc. S. Austr., vol. xliii., 1919, pp. 59-65) reference is made to the "finger-like processes" being noticeable in the anterior portion of the girdle, and the "spear-head spicules" being set opposite them and apparently having some relation thereto. In January, 1920, I collected a very well-preserved specimen at Marino, South Australia, which was free from the usual foreign growth. In this specimen, which is 60 mm. in length, the finger-like processes of the girdle extend right round, and the remarkable "spear-head spicules" are placed opposite these, right round the girdle. In a letter, dated October 17, 1921, Mr. S. Stillman Berry, of Redlands, California, writes me in answer to a letter of mine referring to some remarks that had been made in reference to these strange spicules on *Loricella*:—"I have worked on those *Loricella* and *Kopionella* spicules just enough to know that I want to go into the matter of their structure a great deal more meticulously, which will mean a lot of work in the preparation of slides and so on. I cannot understand how anyone can interpret chiton setae as algae."

DESCRIPTION OF PLATE III.

Fig. 1*a*. *Acanthochiton mayi*, Ashby, portion of median valve. Type.
,, 1*b*. ,, ,, ,, median valve. Co-type. × abt. 13 times.
,, 2*a*. ,, *shirleyi*, Ashby, portion of posterior valve. Type.
,, 2*b*. ,, ,, ,, portion of median valve. Type.
,, 2*c*. ,, ,, ,, median valve. Co-type. × abt. 11 times.
,, 3. ,, *gabrieli*, Ashby, portion of median valves showing longitudinal striae in dorsal area. Type.
,, 4. *Callochiton platessa*, var. *fossa*, Ashby, portion of 7th valve showing pits.

A NEW ISOPOD FROM CENTRAL AUSTRALIA BELONGING TO THE PHREATOICIDAE.

By CHARLES CHILTON, M.A., D.Sc., C.M.Z.S.,
Professor of Biology, Canterbury College, New Zealand.

(Communicated by Professor F. Wood Jones).

[Read April 13, 1922.]

In this paper I describe a new and most interesting fresh-water Isopod kindly sent to me by Professor F. Wood Jones, of Adelaide University. It was collected in June, 1920, in artesian water from the Hergott (Marree) bore, in Central Australia, a little south of Lake Eyre.

The animal proves to belong to the Phreatoicidae and comes sufficiently near the typical genus *Phreatoicus* to be placed in it. The Phreatoicidae is a family of fresh-water Isopods of which the first member was described in 1883, from the underground waters of the Canterbury Plains in New Zealand. Later on other species of the genus, and of closely allied genera, were described from the surface and underground waters of Australia, and, still more recently, Barnard (1914, p. 231) recorded a species of *Phreatoicus* from the mountain streams of Cape Colony, South Africa. The family is quite distinct from all the other families of the Isopoda, and forms, by itself, the sub-order Phreatoicidae, marked by some primitive characters and by a striking but superficial resemblance to the Amphipoda. The characters and distribution showed that the family must be an ancient one, and in 1918 this was proved by the discovery of a fossil species from the Triassic beds of New South Wales. The fossil form is not very different from some of the existing species, and, apparently, members of the family have been living in fresh waters on some part of the Australian continent from Triassic times up to the present. The discovery of another quite distinct species in Central Australia is most interesting and important as confirming the conclusions already arrived at. Further details of the history of the family will be found in my paper describing the fossil species (Proc. Roy. Soc. N.S. Wales, vol. 51, p. 383).

The mode of occurrence of the new species is worthy of note. In his first letter, Professor Wood Jones said:—"Hergott is a pure artesian bore; the water is hot, and the creatures were in thousands swimming in the hot water near the bore head." The specimens sent were found to possess well-developed eyes and to be of a dark-slaty colour, so that they evidently had not come up the bore from underground waters. On my pointing this out and asking for further particulars, Professor Wood Jones wrote:—"Now I have asked everyone who knows, and I am assured that all the water is bore water pure and simple At Hergott there are natural springs—that is why the place sprang into existence. I have never seen the springs; they are some three miles away from the place where the bore was sunk. . . . The bore is just on the desert—the water flows on the desert where previously no water was (there is no old watercourse into which the bore water has found its way, as at Clayton and Dulcanina)." It is no wonder, therefore, that it is the popular belief that the animals came up the bore, for this is, as Professor Wood Jones says, "the local story of all bore-water fauna." He adds that it is curious that though every party that has gone into the centre of Australia has based on Hergott, no one has noticed or collected the Isopod, although the hot water of the bore is full of them. When he was there they were in countless numbers, all swimming against the hot current. He did not take the temperature of the water, but says, "It is very hot; steam arising from it "

Like other Isopods, the *Phreatoicus* carries its eggs in a brood pouch underneath the body till the young are hatched out and, probably, for some time longer, the young then being similar in form to the adults. It is, therefore, a little difficult to see how they have got from the spring, or other natural water from which they must have come, to the bore water in which they exist in such numbers. It is, of course, possible that when the natural water dries up they become encased in the dried-up mud, retaining the power of vitality and resuming activity as soon as the water reappears, but that does not explain how they have got from the natural springs, situated near Marree, to the bore water, three miles distant. It is, however, clear that they must be widely distributed and abundant in springs and natural waters in the district, for Professor Wood Jones, in a letter dated October 5, 1921, states that in a recent trip he collected specimens from the mound springs, near Coward, just to the westward of Lake Eyre south. There are, he says, many of these springs, and they vary greatly in salinity and temperature, but the animal was found in all the springs, from Bullakaninna to Coward, an area of some 30 miles.

In this connection it is worthy of note that another member of the family, *Phreatoicopsis terricola*, Spencer and Hall, was found in burrows on the banks of the Upper Gellibrand River (Spencer and Hall, 1896, p. 13). This species has since been recorded from the Otway forest; from Mount William, near Ararat; and from the Grampians (Raff, 1912, p. 70). Another species, *Hypsimetopus intrusor*, Sayce, occurs in the burrows of the land crayfish, *Engaeus cunicularius*, in Tasmania (Sayce, 1902, p. 218). The remaining species of the family appear to be genuinely aquatic, being found in surface or underground fresh-water streams.

Although the species under consideration is being placed for the present under the genus *Phreatoicus*, it differs from the other members of the genus in at least two characters. The more evident of these, though not the more important, is the greater expansion of the basal joints of the last three pairs of peraeopoda, as shown in figs. 1 and 10 In the other species of the genus these joints are comparatively narrow, as in most Isopods(1); but in the present species the expansion is fully as great as that in most Amphipoda, and still further increases the resemblance to an Amphipod, caused from the laterally compressed form of the body. It may be mentioned, however, that the next joint, the ischium, is comparatively long—longer than the succeeding joint, the merus—while, as I have elsewhere pointed out (1894, p. 205), in Amphipoda, with broadened basal joints, the ischium is usually quite short.

The other point of difference, though less evident, is of more real importance, *viz.*, the apparent absence of the coxal joints of all the peraeopoda. In other species this coxal joint, though small, is quite well marked and can be readily recognized as the first joint of the limb, for it is not flattened into a side plate or "epimeron," as it is in most Amphipoda. In *P. latipes* the pleura of the first four segments are produced downwards and outwards so as to hide the base of the leg, and even when the attachment of the limb to the inner side of the pleuron is examined, nothing is seen that can be definitely recognized as the coxal joint. Consequently it must either have become fused with the pleuron, but if so without any suture or mark indicating its presence, or it is quite absent. Calman (1909, p. 202) has some interesting remarks on the development of the coxal joint of the peraeopoda in various Isopods, and gives examples in which it appears to replace the pleural expansion of the segment, though, in that case, it is marked off from the segment on the dorsal surface by a distinct suture, except in the first segment, where there is no suture, and in some of the Oniscoidea in which the suture on the other segments also may disappear.

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(1) The basal joints are slightly broadened in *Phreatoicus australis.*

The species of *Phreatoicus* now under consideration may be described as follows:—

PHREATOICUS LATIPES, n. sp.

Figs. 1-14.

Specific diagnosis.—Body stout. Peraeon (fig. 2) broad, not laterally compressed, moderately convex with the pleural portion of the first four segments projecting outwards and slightly downwards so as to conceal the basal joints of the legs. Pleon short, about half the combined length of the cephalon and peraeon, moderately compressed laterally, pleural portions of the segments produced downwards, their lower margins being rounded and fringed with a few setae. First segment of peraeon short and immovably joined with the head but with the suture well marked, pleural portion of segment free and produced anteriorly about half-way along the lower margin of the head, those of the second and third segments less produced anteriorly. Eye well developed, irregularly rounded or subtriangular, black. Surface of the body covered with small scattered setae, nearly smooth but with slight wrinkles or irregularities on most of the segments. Sixth segment of peraeon united with the terminal segment, or telson, but distinctly marked off from it by a well-defined suture running obliquely backwards from the upper pleural portion of the fifth segment to the base of the uropod (fig. 4). Terminal segment strongly arched above, sides widely separate below, the mid-dorsal end portion showing as a slight process in side view and when seen from above having a median indentation between two rounded lobes, each of which bears three or four setules. (Fig. 3.)

First antenna more than half the length of the second, joints of the flagellum not broadened. Second antenna nearly as long as the head and first two segments of the peraeon.

The mouth parts do not differ greatly from those of *Phreatoicus australis*. In the mandibles the palp is rather short, the third joint being quite short and bent at right angles to the second. There are two strongly chitinized cutting edges in the left mandible; in the right the inner one is small and colourless, as in *P. capensis*. The first maxilla has about six plumose setae at the apex of the inner lobe. In the second maxilla the two outer lobes are very slender, bearing long pectinate setae; the inner lobe is broader and rounded, densely setose, and fringed along its inner margin with a very regular and distinct row of long setae. In the maxilliped, the epipod is nearly circular, thin; the second joint bears a very distinct row of plumose setae projecting inwards towards the mouth cavity; the palp is of the usual structure.

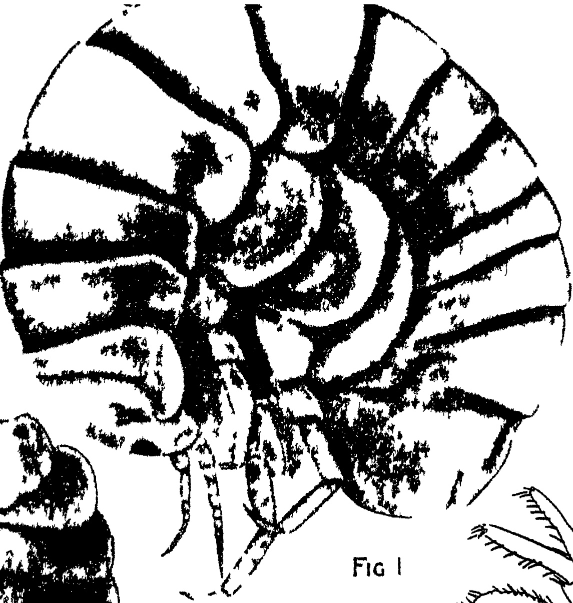


FIG 1

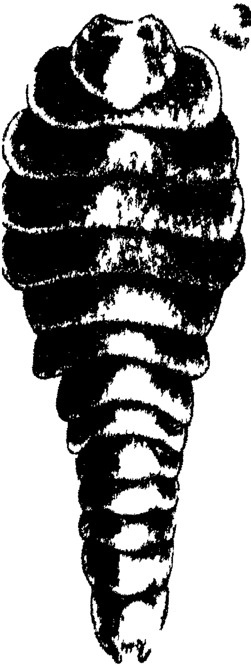


FIG 2

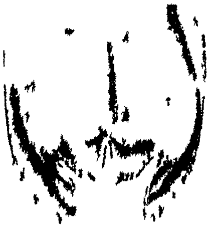


FIG 3

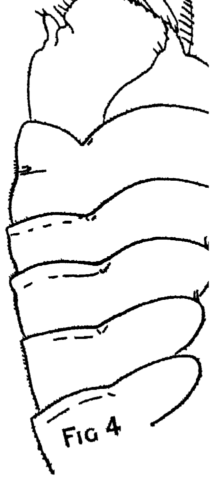


FIG 4

All the figures refer to *Phreatoicus latipes* and are taken from a male specimen

Fig 1 Side view of the whole animal

,, 2. Dorsal view of body

,, 3. Dorsal view of end portion of terminal segment

,, 4. Side view of pleon, straightened out to show the anterior segments more clearly

First pair of legs strongly subchelate; second and third similar to one another, feebly subchelate; fourth pair more slender and not specially modified in the male; fifth, sixth, and seventh pairs increasing progressively in length, their basal joints flat and greatly produced posteriorly into a rounded lobe similar to that in many Amphipoda, the lobe marked off from the joint proper by a distinct ridge, posterior margin of the lobe entire (fig. 10).

Uropods short, not projecting much beyond the end of the terminal segment, outer branch slightly shorter than the inner.

Colour.—Dark slaty-grey. In some young specimens the surface of the body is lighter in colour with dark pigmented spots much more widely separated from one another than in the adult.

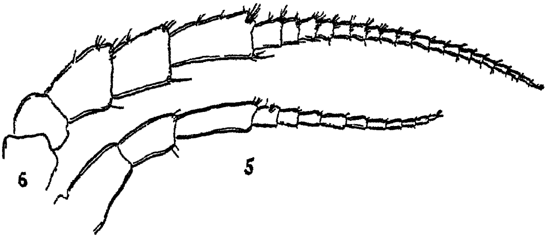
Length of body (in curved position), about 15 mm Greatest breadth of peraeon, about 6·5 mm.

Locality.—In hot water from Marree (Hergott) bore, and in springs and streams near Coward, Central Australia. Collected by Professor F. Wood Jones, Adelaide University.

Remarks.—Although in the flattened character of the peraeon and the greatly broadened basal joints of the last three pairs of legs this species differs markedly from other species of *Phreatoicus*, there seems to be a fairly close resemblance in the various appendages, so that it will not be necessary to give a very detailed account of these.

The first antenna (fig. 5) is slender, the first and third joints of the peduncle similar and considerably longer than the second; the flagellum is about the same length as the peduncle and contains about ten joints, which bear short simple setae and a few olfactory setae. The second antenna (fig. 6) is considerably longer and stouter than the first; the first two joints of the peduncle are short, the third about twice as long as the second and subequal with the fourth, the fifth longer and more slender; the flagellum is subequal in length with the peduncle and contains about nineteen joints, the basal ones being somewhat stout and bearing tufts of numerous short simple setae.

In the male the legs of the first pair (fig. 7) are strongly subchelate, the propod being subtriangular and greatly broadened at the base, the finger not reaching beyond the straight palm. In general appearance this appendage is similar to that of *P. australis*. The second and third pairs of legs (fig. 8) are similar, longer, and more slender than the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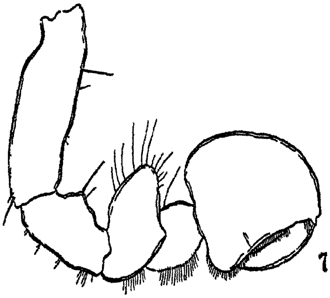
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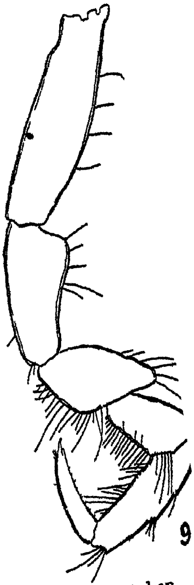
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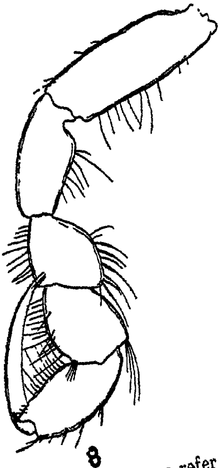
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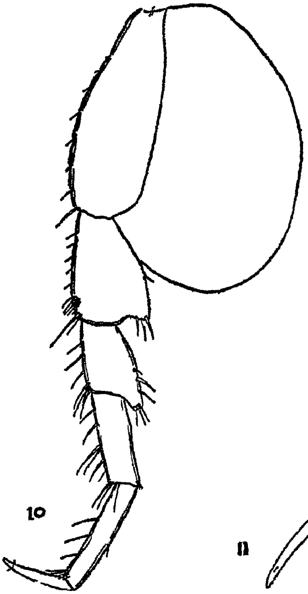
All the figures refer to *Phreatoicus latipes* and are taken from a male specimen.

Fig. 5. First antenna.
" 6. Second antenna.
" 7. First peraeopod.
" 8. Third peraeopod.
" 9. Fourth peraeopod.

first; the propod is not broadened, but the finger is very long, slightly curved, and when flexed reaches back as far as the basal portion of the carpus, forming apparently an efficient grasping organ. The fourth leg (fig. 9) is slightly longer than the third with the joints more slender, and it is not subchelate but simple, the finger not longer than the propod. This appendage is the same in both male and female, although in some other species of *Phreatoicus* the legs of the fourth pair are modified in the male to form a special grasping organ. The fifth, sixth, and seventh pairs are quite similar, increasing progressively in length posteriorly. The basal joint in each is very greatly expanded behind into a rounded lobe projecting backwards and downwards, reaching two-thirds of the way to the distal end of the ischium. This expansion is marked off from the joint proper by a distinct ridge running parallel to the anterior margin; the posterior margin of the lobe is entire and bears no setae; the ischium is distinctly longer than the merus and, like it, broadened somewhat distally; the carpus and propod are cylindrical; the finger is straight, acute; these joints show setae of varying sizes, as indicated in the figure (fig. 10).

The male appendages (fig. 11) on the seventh peraeon segment are slender, tapering, curved inwards towards one another, slightly swollen at the base, and apparently grooved on the posterior surface.

The pleopods show a close general resemblance to those of *P. australis*. The first pleopod has the basal joint or protopod short, the endopod and exopod subequal, each forming an irregular oval lobe, the margin of the endopod being smooth and without setae, as in all the pleopods, the outer margin and apex of the exopod being fringed with fine setae. The second pleopod in the male (fig. 13) has the basal joint broader and bearing a few long setae at its inner margin; the endopod is similar to that of the first pleopod, but bears on the inner side the penial appendage, which is four-fifths as long as the exopod, broadened near the base and apparently grooved on its upper or anterior surface; the exopod is larger than the endopod and consists of two joints, the basal one about as long as the endopod and produced at its outer proximal angle into a broad rounded lobe; the terminal joint is small, oval, and has its margins fringed with long setae, a few long setae being also present on the distal portion of the outer margin of the basal joint. The third (fig. 14), fourth, and fifth pleopods are similar to the second, except for the absence of the penial appendage, and they all bear attached to the outer margin of the basal joint a large



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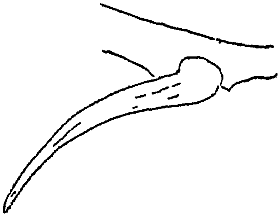

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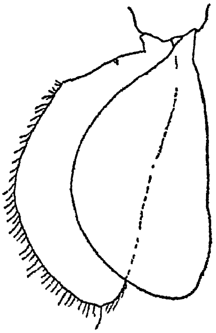

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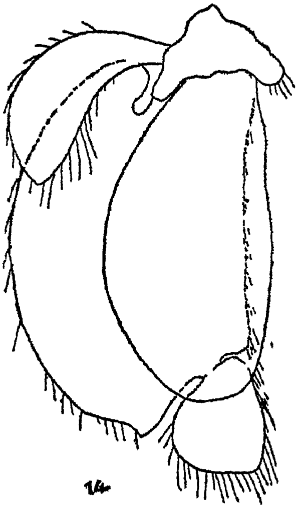

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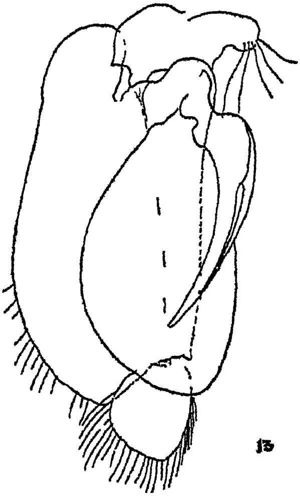

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All the figures refer to *Phreatoicus latipes* and are taken from a male specimen.

Fig. 10. Seventh peraeopod (less highly magnified than figs. 7, 8, and 9).

,, 11. Male appendage.

,, 12. First pleopod of male.

well-developed oval epipod," the margins of which are fringed with long setae.

The uropods are similar to those of other species of *Phreatoicus*, having the basal joint subequal in length with the branches, its upper margin fringed with stout setae, the upper margin of each branch being similarly fringed

Affinities.—Until it is possible to make a revision of the Phreatoicidea this species may be left under the genus *Phreatoicus*. It shows a good general resemblance to *P australis*, but differs markedly from that species, and indeed from all the members of the tribe, in the absence of the coxal joints of the peraeopoda. It resembles *P. australis* in having the first peraeon segment short and more or less fused with the head, in this character agreeing also with *Phreatoicopsis terricola*, Spencer and Hall. It agrees with the latter species and differs from *Phreatoicus australis* in the fact that the fourth peraeopod is not specially modified in the male. The sixth segment of the pleon, although fused with the terminal segment, or telson, appears to be more distinctly marked off from it by a distinct suture than in the other species: in *Phreatoicus australis* there is a suture present, but this extends anteriorly only a short distance from the base of the uropod and does not reach the posterior margin of the fifth segment. In most Isopods, except the Anthuridae, the sixth segment is completely fused with the telson without any apparent suture to indicate the line of juncture.

I am greatly indebted to my assistant, Miss E M. Herriott, M.A., for preparing the drawings for this paper, and to Professor F. Wood Jones for the opportunity of describing this interesting species.

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THE FLORA AND FAUNA OF NUYT'S ARCHIPELAGO AND THE INVESTIGATOR GROUP.

No. 1—THE AMPHIPODA AND ISOPODA.

By Charles Chilton, M.A., D.Sc., C.M.Z.S.,
Professor of Biology, Canterbury College, New Zealand.

(Communicated by Professor F. Wood Jones.)

[Read April 13, 1922.]

The crustacea referred to in this short paper were collected by Professor F. Wood Jones, of Adelaide University, in an expedition made towards the end of 1920 to the Investigator Group and the Nuyt's Archipelago, lying to the west of Eyre Peninsula, South Australia. The whole of the species here mentioned were, however, obtained at the Nuyt's Archipelago, most of them in Smoky Bay. They are all referred to species already known, though in some cases they have not been hitherto recorded from South Australia.

In addition to these species numerous specimens of terrestrial Isopods, belonging to *Cubaris* and allied genera, were collected from several localities. These have been sent for determination to Dr. W. E. Collinge, York Museum, England. Several shore Amphipoda (*Orchestia*, etc.) were obtained at various places, but they are all too immature for determination.

AMPHIPODA.

Leucothoe spinicarpa (Abildg.).

Leucothoe spinicarpa and *L. miersi*, Stebbing, 1906, p. 165.

Leucothoe commensalis, *L. diemenensis*, and *L. gracilis*, Stebbing, 1910, p. 636.

Leucothoe spinicarpa, Chilton, 1912, p. 178, and 1921, p. 59; Barnard, 1916, p. 148.

Locality.—Smoky Bay, South Australia, 3·5 to 4 fms. Two specimens; length, 10 mm.

In my report on the Amphipoda collected by the F.I.S. "Endeavour," I have given reasons for considering all the forms mentioned above as belonging to the cosmopolitan species, *L. spinicarpa* (Abildg.). The species seems to be common at numerous places on the Australian coasts. Barnard has given some further particulars of specimens from South Africa, and has added *L. miersi*, Stebbing, to the list of synonyms, as I had already done in my MS. notes.

GRUBIA SETOSA (Haswell).

Amphithoe setosa, Haswell, 1879, p. 270; Chilton, 1885, p. 1040.

Grubia setosa, Stebbing, 1906, p. 644, and 1910, p. 649.

Locality.—Mangrove Creek, Smoky Bay. Several specimens.

I refer these specimens to the species named with some doubt, for they are all small and immature, and the species itself is imperfectly known. The typical species of the genus, *G. crassicornis*, is known from the Mediterranean and the Black Sea, and a South African one has been described by Barnard under the name *G. australis*. It will be necessary to compare adult specimens of these three species before anything can be said about their affinities.

ISOPODA.

DETO MARINA (Chilton).

Deto marina, Chilton, 1915, p. 444, pl. 39, figs. 19-23.

Deto marina, Chilton, 1917, p. 399, figs. 15-21.

Localities.—Smoky Bay, 21-xi.-20. Two specimens. Laura Bay, 23-xi.-20. Five specimens. Eyre Island, Smoky Bay, 21-xi.-20, Several specimens. Unnamed guano island, Laura Bay, 22-xi.-20. Two specimens.

This species was originally described under the name *Philougria marina* from specimens collected at Coogee, New South Wales, in 1884. No further specimens were obtained from the type locality until towards the end of 1920, when several were obtained by Mr. F. A. McNeill, of the Australian Museum, Sydney. It had been collected at Kangaroo Island, South Australia, by W. H. Baker, in 1915; and I have since had specimens from Tasmania, collected by A. M. Lea, of the Adelaide Museum. Apparently it is fairly common in the localities examined by Professor F. Wood Jones, and was obtained at the four places mentioned above. The specimens agree closely with the description given of those from Kangaroo Island.

Mr. F. A. McNeill, who collected the specimens from Coogee, states that they were found on the damp undersurfaces of stones which formed heaped accumulations of small sandstone boulders at highest tide mark and ended among the dark crevices and overhanging shelves of larger rocks, from 10 to 15 ft. further back. He further states that the animals are "slow in movement, often lying motionless in the irregularities on the surface of the stones; the older examples rarely move away until disturbed previous to capture," and he contrasts their slow movement with the active movements of *Ligia australiensis*, which was found at the same time and place, and was so active that it was very difficult to capture. I had noticed the same characteristic habits in the species *Deto bucculenta*, Nicolet, found on the shores of Paterson Inlet, Stewart Island, New Zealand (1917, p. 404).

In my paper on the genus (1915) I have drawn attention to the distribution of the different species on islands and other land masses in southern seas.

PARIDOTEA UNGULATA (Pallas).

Idotea ungulata, Miers, 1881, p. 52; Chilton, 1890, p. 196.

Paridotea ungulata, Stebbing, 1900, p. 53; Collinge, 1918, p. 81.

Locality.—Mangrove Creek, Smoky Bay. Four specimens; length of largest, 40 mm.

Colour (in spirit).—Olive-green with lighter patches somewhat irregularly arranged in longitudinal rows.

These specimens agree, generally, with New Zealand specimens referred to this species, though the colour is a little different, and the first segment of the pleon seems rather more distinct and slightly longer in the median line; in the New Zealand specimens this segment is less distinctly marked and in the median line is nearly concealed beneath the last segment of the peraeon. Collinge (1918, p. 82) has established a new variety, *atrovirens*, for specimens from Victoria, Australia, having the "whole of the body a very dark olive-green, almost black." From the details given by Miers and by Stebbing the colour appears to vary considerably in this species. Most of the New Zealand specimens that I have been able to examine in the living condition are a light green, corresponding with the colour of the green seaweeds on which they are usually found.. This colour disappears in spirit specimens, leaving them a yellowish-brown. Some of my specimens, however, still have (in spirit) the whole body more or less darkly coloured; sometimes the whole body, sometimes certain portions only, being finely dotted with black.

The mouth parts have been described by Stebbing, and also by Collinge, the two descriptions showing considerable differences. I have a slide with the mouth parts of a small New Zealand specimen mounted about the year 1890. In it the first maxilla has the inner plate narrower than in Collinge's figure and with only three plumose setae at its extremity. Collinge found four and Stebbing (apparently describing South African specimens) found ten; the outer lobe of this maxilla bears about ten stout spines with one or two more slender ones agreeing on the whole with Collinge's figure, though the arrangement differs a little in detail. The maxilliped agrees pretty closely in general shape with the figure given by Collinge, but the parts corresponding to the second and third joints of the palp, as described by him, are almost completely fused, the suture between them being very indistinct compared with the articulations of the other segments; consequently the palp appears four-jointed as described by Stebbing.

Distribution.—The species is very widely distributed in southern seas.

Idotea excavata, Haswell, comes near to this species, and I referred it to *Paridotea ungulata* in 1890, though, at the same time, pointing out several slight differences.

CYMODOCE LONGICAUDATA, Baker.

Cymodoce longicaudata, Baker, 1908, p. 138, pl. iii., figs 1-11.

Locality.—Mangrove Creek, Smoky Bay. Four specimens.

These specimens agree well with Baker's description, though in the largest (length of body with terminal spine, 15 mm.) the terminal spine, the branches of the uropoda, and the side-plates of the peraeon are longer and more acutely produced than in his figure.

A specimen of this species has recently been sent to me by Professor F. Wood Jones, labelled "Onkaparinga River, Mt. Lofty," presumably in fresh water.

ZUZARA VENOSA (Stebbing).

Zuzara venosa, Baker, 1910, Trans. Roy. Soc. S. Austr., vol. xxxiv., p. 83, pl. xxiii., figs. 13-16, and pl. xxiv., figs. 1-3.

Several specimens, taken on the shore of Streaky Bay, South Australia.

Of these, three are fully adult males; the others, females or immature males, showing different stages in the development of the process in the seventh segment of the peraeon.

This species was redescribed and well figured by Mr. W. H. Baker in 1910. He states that it is one of the commonest marine Isopods of the shores of South Australia.

PORCELLIO LAEVIS, Latreille.

Porcellio laevis, Chilton, 1905, Ann. Mag. Nat. Hist., ser. 7, vol. 16, p. 430.

Porcellio obtusifrons, Haswell, Cat. Austr. Crust., p. 284.

Two specimens, taken on the shore of Streaky Bay. This is an introduced species which is now almost cosmopolitan. I have given some notes on its distribution in Australia in the paper quoted above.

METOPONORTHUS PRUINOSUS (Brandt).

Metoponorthus pruinosus, Chilton, 1905, *l.c.*, p. 431.

One specimen, on the shore of Streaky Bay. This is another introduced species that is now very widely distributed.

Synonyms and notes on its distribution are given in the paper quoted.

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THE EXTERNAL CHARACTERS OF POUCH EMBRYOS OF MARSUPIALS.

NO 3—*ISOODON BARROWENSIS.*

By F. Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read April 13, 1922]

Of this bandicoot I have so far obtained but three embryonic stages for description. For all these specimens I am indebted to the authorities of the Perth Museum. As opportunities for obtaining further material may be long delayed, and as the three stages (17 mm., 77 mm., 92 mm) examined are representative of a long cycle of pouch life, it has been thought worth while to record such details as are ascertainable from the study of these specimens

Hair.—Hair is evidently late in development, there being no appearance of general body hair at the 77 mm. stage In the embryo of 92 mm. the general body hair is developed, and is of the characteristic hispid type and bright tan in colour.

Hair Tracts.—In general disposition the stiff harsh hair of the 77 mm. embryo exhibits the utmost simplicity.

With the exception of one field, the whole of the hair of the head, body, and tail slopes uniformly backwards (see fig. 1). The exceptional area, which may be defined as the gular field, is situated beneath the throat, extending from the angle of the mouth to the root of the neck. In this field the hair trend is completely reversed. The anterior convergent region beneath the chin is marked by the interramal papilla and its vibrisca; the posterior divergent region is situated at the posterior extremity of the base of the skull. The lateral margins of the area are very definite, and they extend backwards from the angle of the mouth practically along the lines of the rami of the mandibles (see fig. 2).

Upon the limbs the flow is distal and towards the post-axial margin, but in the case of the fore limb a reversal takes place at the post-axial margin between the wrist and the elbow. Hair is continued to the base of the ungual phalanx of both fingers and toes (see fig. 3).

The sole of the foot is hairy and the arrangement of the hair tracts is very definite. A central divergent area is present upon the sole opposite the first digit Behind this point the hair is arranged in two streams running backwards to the heel and towards the mid line. This backwardly-directed stream meets around the heel with the descending stream from the leg. In front of the central point the streams are directed forwards along the syndactylous digits, and the fifth digit, respectively (see fig 11).

The hair colour of the specimen in which hair is uniformly developed (Perth, B, 92 mm.) is a bright tan, the dorsal surface being of a darker tint than the ventral surface.

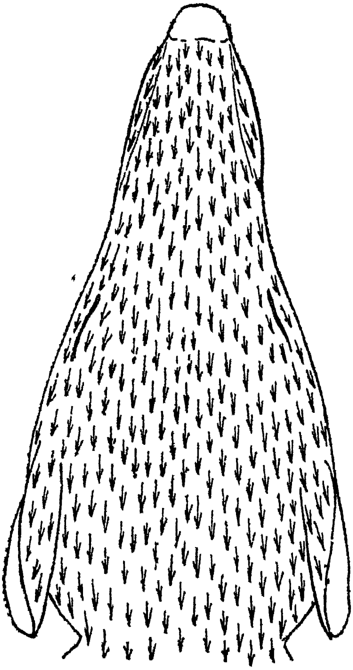

Fig. 1.

Hair tracts of the head (from Specimen Male B, Perth).

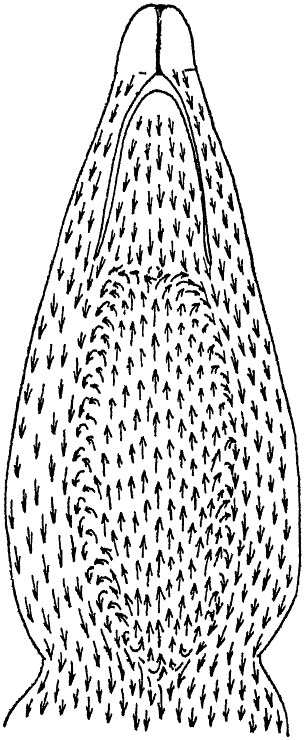

Fig. 2.

Gular hair tracts (from Specimen Male B, Perth).

CUTANEOUS PAPILLAE AND VIBRISCAE.

Facial Vibriscae.—The sensory vibriscae and papillae are not very conspicuous. By far the largest papilla is the genal which gives origin to some six backwardly-directed vibriscae. The mystical set is arranged in five rows, of which a single papilla constitutes the upper row. The vibriscae are fine and

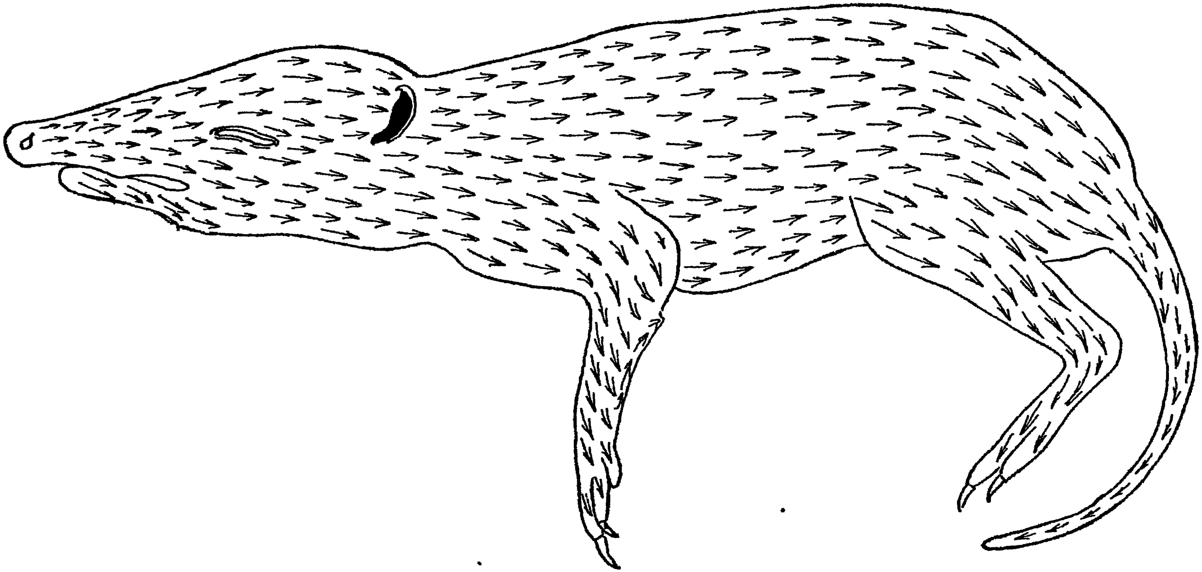

Fig. 3. Hair tracts of the body (from Specimen Male B, Perth).

pale in colour. A single vibrisca springs from the interramal papilla. The submental vibriscae are short and insignificant. The supra orbital papilla gives rise to two backwardly-directed tactile hairs (see fig. 4).

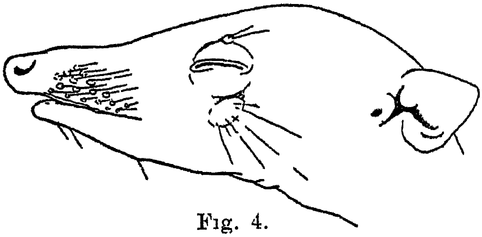

Fig. 4.
Facial vibriscae (from Specimen Male A, Perth).

Brachial Vibriscae.—The ulnar carpal papilla gives origin to a single very elongated bristle as well as to an unusually short one. A single well-developed anconeal vibrisca is present (see fig. 5).

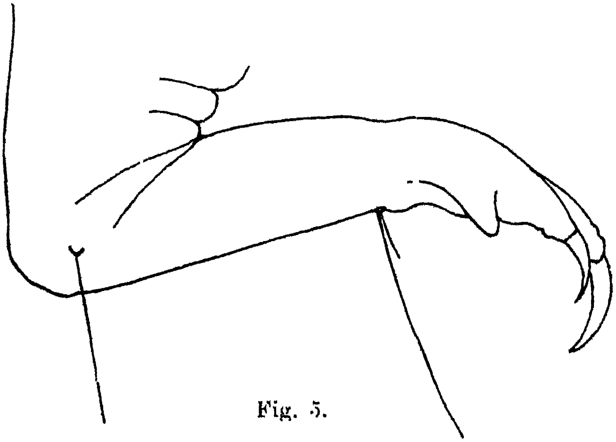

Fig. 5.

Brachial vibriscae (from Specimen Male A, Perth).

There are no crural vibriscae or papillae present on any of the embryos that I have examined. There are no specialized cloacal vibriscae.

Rhinarium.—The rhinarium is naked and elongated. The middle line sulcus of the upper lip is well marked and grooves the rhinarium to the posterior extremity of its dorsal surface. The naked surface is flesh coloured, and it is granulated in a regular manner suggesting mosaic. The slit-like narial apertures are directed laterally, and their margins are entirely naked. The posterior limit of the rhinarium becomes more defined in later embryos as the snout region becomes pubescent (see fig. 6).

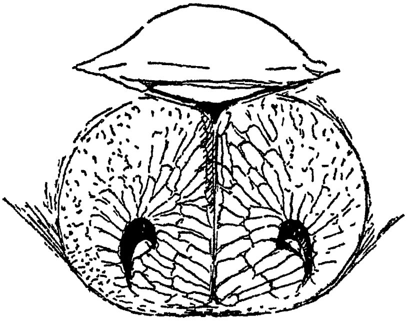

Fig. 6.
Rhinarium (from Specimen
Male A, Perth).

External Ear.—In no embryo of the genus *Isoodon* that I have so far had the opportunity of examining is the ear laid forward at the younger stages. In *I. barrowensis* the pointed ear stands well out from the side of the head with the

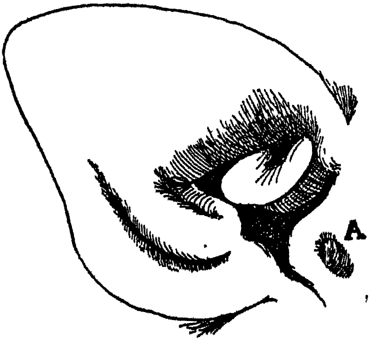

Fig. 7.
The form of the external ear
(Embryo Male A, Perth).

tip directed backwards. The processus antihelicis (the so-called metatragus) is large in all stages; the characteristic adult twist in its length becoming more pronounced as growth proceeds. Nearer to the external auditory meatus than the metatragus of the taxonomist is a second and smaller process of the antihelix which, by becoming separated from the main process with the enlargement of the auricle, leads, in the adult, to the formation of a pit between the two processes. The "deep hollow" described in this area of the adult ear is, however, a secondary feature formed by the relative growth of the surrounding parts.

Two genuine pockets are, however, present in the auricle. The first is the common mammalian pocket in the posterior portion of the helical margin, and which is generally known as the sulcus auris posterior. The second pocket is a remarkable one (marked A in figs. 7 and 8) in the centre of the developing tragus. This tragus pocket becomes covered by the hair of the cheeks in the adult, nevertheless it remains a permanent and remarkable feature of the external ear.

Manus.—The digital formula is $2=3>4>5>1$. Claws are developed at the 17 mm. stage upon digits 2, 3, and 4; but 1 and 5 are clawless. The digits are fusiform, tapering towards their distal extremities; there are no definitely developed apical pads. Three basal pads are developed, one being opposite the base of each clawed digit. The skin of the palm is granular (see fig. 9).

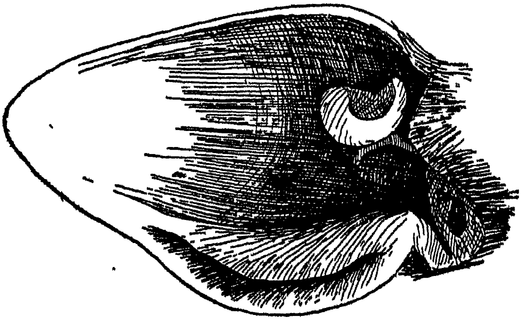

Fig. 8.
Form of the external ear (from Specimen Male B, Perth).

Pes.—The digital formula is $4>5>\overbrace{2:3}>1$.

The outstanding features of the foot are the great size of the fourth digit and the reduced condition of the first, which bears no claw. The digits are fusiform. Three basal pads are present, one being at the base of digit 5, a larger one at the base of 4, and a small one at the base of the syndactylous elements.

In the 77 mm. embryo the sole is uniformly granular, but at 92 mm hair has clothed a large area of the plantar surface of the pes and of digits 2 and 3 (see figs. 10 and 11).

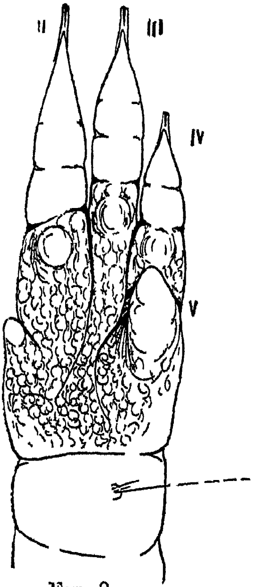

Fig 9.

Palmar surface of the left manus (from Specimen Male A, Perth).

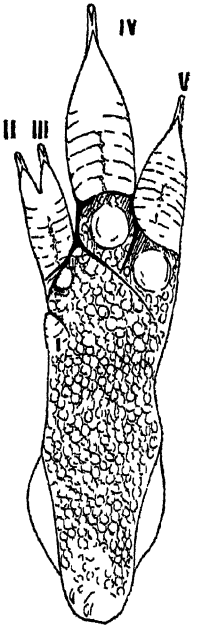

Fig 10

Plantar surface of the left pes (from Specimen Male A, Perth).

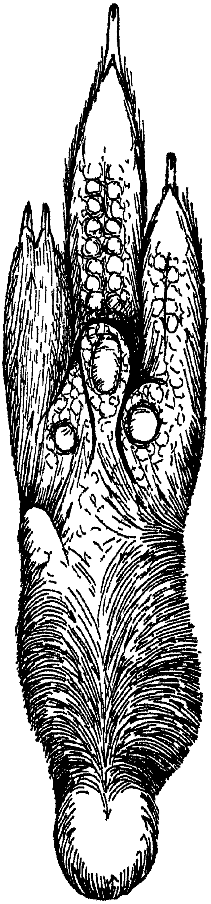

Fig 11

Plantar surface of the left pes (from Specimen Male B, Perth).

External genitalia —The genital tubercle of the male is extra-cloacal at the 17 mm. stage, and intra-cloacal at the 77 mm. stage The opening of the pouch in the female is directed downwards and backwards

A GEOLOGICAL TRAVERSE OF THE FLINDERS RANGE FROM THE PARACHILNA GORGE TO THE LAKE FROME PLAINS.

By PROFESSOR WALTER HOWCHIN, F.G.S.

[Read May 11, 1922.]

PLATE IV.

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In 1906 the present writer crossed the Flinders Range from Parachilna, westerly, to the eastern slopes bordering on the Lake Frome plains. The journey was done mostly on foot. Publication of results was deferred with the hope that opportunities might arise by which the geology of the country could be still further investigated and descriptions made more complete. As this is now unlikely, the present notes are placed before the Society as a summary of the work done at the date mentioned, incidental to defects which must necessarily accompany observations made on a single traverse of the region.(1)

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(1) Some preliminary notes of this journey were included in a paper by the author, read at the Adelaide meeting of the Aus. Assoc. for Adv. of Science (1907), on "A General Description of the Cambrian Series of South Australia," pp. 414-422.

The typical structure exhibited by the Flinders Ranges takes the form of broad anticlinal and synclinal folds which, by complicated directions of pressure, frequently produce periclinal domes with complementary saucer-shaped depressions, the latter being locally known as "pounds." The geological section, now under description, is transverse to one of the most extensive dome-structures in the ranges, the centre of the dome being situated, approximately, near the township of Blinman, with the superior beds dipping away in circles around this centre. A few miles to the south of Blinman is the Wilpena Pound, formed by a complete circle of mountains with the gap made by the Wilpena Creek, the only means of ingress and outlet to the basin. At Mernmerna, on the great northern line, the hills on the eastward side of the line form very steep escarpments with rugged peaks, forming the western limits of the Elder and Wilpena Pound Ranges This precipitous face continues, northwards, to Parachilna, as a fault-scarp, making the eastern boundary of the great rift valley of South Australia in that direction.

As the present paper is based on a single visit to the locality, and an interval of about sixteen years has passed since the observations were made, the paper is practically limited to the itinerancy and the field notes made at the time. The Geological Section, published herewith, was drawn soon after the author's return to Adelaide. The newer, southerly road was followed going out, and the older, northerly road on returning, when the journey was made by coach.

I. PARACHILNA GORGE.

ENTRANCE TO THE GORGE.

The Parachilna railway station is situated on the plains skirting the eastern side of Lake Torrens, about seven miles from the foot of the ranges. The gap in the ranges, east of the railway station, has been cut by the Parachilna Creek, forming a narrow and very picturesque gorge In approaching the gorge the first rocks met with are limestones that outcrop on the road, near an old house in ruins. These are subcrystalline, of a coarse-marble kind, much broken and penetrated by veins (dip S. 20° W. at 46°), underlying which are limestones containing Archaeocyathinae. The country along the face of the great escarpment is much faulted. Following the western escarpment, going south, in a second spur, the fossils gradually disappear in a dolomitic matrix, the fossils occurring in every stage of alteration as they become absorbed into the matrix. [On this spur is an isolated group of sandstone boulders, some of which are of great size.] In following the line of outcrop, southwards, there is a narrow belt of dark-coloured oolitic and laminated limestone, apparently brought in, as a repetition of the strata, by a strike fault. The limestones can also be traced up to the great pinnacle of quartzite which cuts them off on the southern side, by a dip fault, the quartzite having an apparent dip of 85°, westerly, on its abrupt face to the west. The outlier of oolitic and laminated limestones, brought in by the strike fault, has a dip S. 30° W. at 55°. The junction of limestone against the quartzite on the fault plane, is a rotten brecciated rock. The last solid rock on the limestone side, is a marble (see fig. 1).

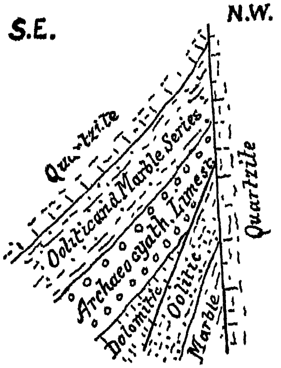

Fig. 1.

Outlier by complex faulting of limestones pinched in between quartzites.

THE GORGE.

On entering the gorge the limestones are seen to outcrop on both sides of the creek, mostly on the southern side, where they form a ridge about 200 ft. high and make a spur, running westward, to the plains, where they pass from view under alluvium and sand. The limestone facing the plains has a strike E. 25° S., dip 45° westerly. The gorge road intersects the limestones obliquely to the strike of the beds and supplies an interesting section, as detailed below:—

(a) The bottom series in the limestone belt begins about half a mile from the entrance of the gorge, resting on thick quartzites which rise to a great height: dip S. 30° W. at 60°. The beds are characterized by a series of dark-coloured oolitic limestones, separated by earthy bands, or beds, which continue as a cliff facing the creek for a distance of 300 yards: dip 60°-75°.

(b) Blue and buff limestones, dolomitic; nodular, stalactitic, laminated; more rarely, finely oolitic in structure; white crystalline limestone, passing into white to brown dolomitic marbles, with reduced angle of dip. About 300 yards of outcrop.

A small tributary creek dissects the cliff at this point, making a gap 36 yards wide, but the limestones continue up this creek.

(c) Pink and yellow marbles continue for a distance of about 50 yards, passing up into very solid and continuous white to buff marbles. Width, 90 yards.

Another wash-out by a small tributary creek, 75 yards wide, with limestones passing up the creek.

Granular marble shows again in cliffs on opposite side of wash-out. Dip S.W. at 40°. These beds continue for 180 yards to another small affluent, where the Archaeocyathinae beds make their appearance with a strike E. 20° S.

(d) Archaeocyathinae limestones, showing extensive development near the outlet of the gorge. The base of these beds cannot well be determined as the fossils gradually disappear, losing their organic structures by conversion into marble or dolomite. This occurs both at the base of the fossiliferous beds as well as at their upper limits.

Immediately on the eastern side of the great limestone series, the Parachilna Creek has broken through a great wall of quartzite, which towers to a great height on either side There follow, in descending order, thick shales with some flags (dip 70°-80°) up to the prominent and peaked hill of quartzite, near the reservoir; underlying which are shales having a strike almost parallel with the road, and a dip of 90°. These shales are often sharply curved and continue in the section to the mouth of the Oratunga Creek, having a dip of from 80° to 90°. From this point, by a sharp bend in the road, the latter follows the strike of the beds, which there have a dip of 75°. The road then crosses the creek and takes a sharp curve round a spur of quartzite, 50 ft. in thickness, with a dip from 70° to 80°. In this angle there is a fault associated with strong V-shaped contortions, the beds being shales with hard, thin quartzites having a dip of 45°. At a short distance from the preceding the road crosses the creek, a second time, where shales have a dip of 60°. At the third, and last time that the road crosses the creek, the shales have a dip of 80° to 85°, with a wavy structure.

At a distance of three miles from the mouth of the gorge limestones once more begin to show themselves in the section. At a sharp angle of the road, just past Mount Mary, there are beds of pink-coloured limestone seen on the road. Shales, with a dip of 45°, occur for a distance of three-quarters of a mile to the "Dairy," where the road is close to the Parachilna Creek and is at the foot of the "Big Hill."(2) The dip decreases towards the "Dairy."

Calcareous grits and arenaceous (oolitic) limestones occur very commonly on the western side of the "Big Hill." There also occur thick flaggy quartzites, 200 ft. in thickness, overlain by pure limestone and gritty oolitic limestone: dip S.W. at 25°. These gritty limestones have a great development on the creeks which pass between the road and the Parachilna

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(2) This is quite distinct from a hill of the same name situated between Blinman and Wirrealpa.

Creek, and these, interbedded with flags and quartzites, represent a series some hundreds of feet in thickness.

Leaving the "Dairy," going east, the road follows the creek, taking the rise of the "Big Hill," showing, in succession, for about a mile, shales (dip 45°); blue limestone, seen in creek; shales (dip 15°-20°); limestone (dip 15°); calcareous grits (dip 15°-20°). The road reaches its greatest elevation between the Gorge and Blinman at the north turn, or bend, known as the "Big Hill," or the "Seven-mile Hill" (measured from Blinman). At this point there is a reef of iron and lime carbonates crossing the road. The Seven-mile Hill is chiefly marked by quartzites, 100 ft. in thickness, with a dip S.W. at from 10° to 15°. [Top-bed (?) calcium-carbonate.] On the eastern side of the "Big Hill" is the "Snake Bend," and at 6¾ miles from Blinman, an arenaceous limestone, 5 ft. 6 in. in thickness, interbedded with flaggy quartzites, occurs. At 6 miles from Blinman, a small quarry is worked in a siliceous limestone, by the side of the road: dip S.W. at 35°. The stone is used for road metal.

II. HORNE'S CAMP.

On the evening of the first day out I reached a spot known as "Horne's Camp," situated on a creek, tributary to Parachilna Creek,⁽³⁾ that crosses the road about 4 miles to the westward of Blinman. A party of Government "roadmen" was camped on the creek, with whom I found accommodation for the night, and spent the following day examining the creeks in the locality.

Facing the camp, from the southward, is a long escarpment that follows the strike and has the appearance of a great rampart giving a clear exposure of the beds. The latter consist of argillaceous and arenaceous flags that split perfectly on the bedding planes. They can also be studied in the creek banks, near the camp. Here bluish quartzites with partings of softer material outcrop with a dip S., and S. 20° E. at 30°. Followed the creek, downwards. At about 400 yards from the camp, a 4-ft. banded limestone occurs that splits up easily into flags. At two-thirds of a mile, in the same direction, dark-coloured fissile flags occur, much like Willunga "slate," having a dip S.W. at 20°. Here the stream that I was following joined a larger creek which came in from the east. At three-quarters of a mile from the above junction, going down stream, a quartzite is met with, 50 ft. in thickness, passing in its upper portions

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(3) The Pastoral Map on which is shown the two creeks referred to is entirely unreliable as to their respective directions.

into flags with a wavy structure, slightly false-bedded. The dip varies from 17° to 20°. The beds that follow are a lenticular dolomite, in quartzite, situated near sharp bend of the stream (seen on the rise); calcareous bands, in flagstones, showing lamination by weathering; the flagstones, in ascending series, become more calcareous and pass into calcareous flagstones. A waterfall, having a height of about 20 ft., occurs on this creek, about one-eighth of a mile before its junction with Parachilna Creek. The section continues in flagstones, quartzites, gritty limestones, and calcareous grits: dip S.W. at 20°. Some of the gritty beds are from 10 ft. to 15 ft. in thickness, and, in places, show ripple marks. The hill, adjacent to waterfall, consists mainly of gritty limestones, and has a height of from 200 ft. to 300 ft.

In the main creek, around a westerly and southerly bend, there is a sudden change in the dip, passing into intense folding and a throw down, by fault, at 90°. The fault area is well defined by walls that are vertical and 14 ft. apart—the fault area is filled by fault-rock. On the eastern side of the fault the dip is N. 65° W. at 40°. On the western side of fault the dip is S.W. with numerous small thrust folds, which extend for 100 yards. At the next bend, one-eighth of a mile below the previous observation, the dip is W. at 30°. At one-eighth of a mile, further down, rapids are formed by a bar of gritty limestone, overlain by flags, and include a thin bed of oolitic marble, 1 ft. in thickness, and having a dip W. at 30°. At another one-eighth of a mile distance, a second strong bar of gritty limestone occurs, making a cliff-bank 500 ft. in height: dip S. 60° W. at 30°. The beds form a synclinal fold. The beds underlying the synclinal curve are oolitic limestones, 20 ft. in thickness, and inferior to these there are impure wavy limestones, with a dip S.W. at 20°.

At this point I left the main creek and followed up a small tributary which drains in from the north-east. In this creek a striking fold occurs which crosses the stream, on the eastern side, the dip is W. at 14°; and on the western side, the dip is N.W. at 80°, in flagstones. Higher up the creek, there is another throw down to N.W. at 67°-80°; the section showing dolomitic limestone in beds from 12 ft. to 18 ft. in thickness. At the head of the creek there are thick quartzites which rise to a crest of about 300 ft. in height, with a shoulder of quartzite, at a lower level; and a yet lower one, of flagstones, which, latter, come down to the level of the road about half a mile westward of the camp.

Spent the second night in camp with the road-men. Next day cut across country to Blinman. Examined travertine near camp. It is exposed in cliffs of the creek both above and below where the road crosses the creek. The beds are horizontal and up to 12 ft. in thickness, the base of the beds is, usually, a few feet higher than the normal level of the creek. The limestone varies from soft, loosely-cemented globular concretions to a compact rock, often finely brecciated.

Went up small creek, adjacent to the camp, going north. At a distance of 200 yards, up the creek, the rocks were found to be argillaceous flags: dip S. 20° W. at 75°, increasing to 85°. At a further distance of 200 yards, further up, thick beds of dolomitic limestone, in rolling folds, with an average dip of 40°. These beds show some extraordinary effects of crush—laminated, contorted, broken, passing into crush conglomerate in which dolomitic limestones and shales are mixed together. This broken area extends for a width of 50 yards, giving no evidence of dip, and is underlain by contorted slaty flags, with a dip S. 20 E. at 80°.

A little higher up the creek, another bed of dolomite (or dolomitic limestone), 9 ft. in thickness, is included in disturbed and broken slates which are in vertical position. Thick quartzites follow a ridge that forms the crest of a very pointed and conspicuous hill on the north side of the camp, and are underlain by very thick dolomite, with a dip of 25°. These beds occupy the creek for one-eighth of a mile, are finely crystalline in texture, and, in quantity, sufficient to rebuild the Westminster Houses of Parliament. The thick dolomite is followed, in descending order, by laminated shales, at a dip of 80°, including a bar of dolomite, and these are underlain by a dark-coloured contact (garnet) rock, which has undergone alteration by contact with an igneous dyke.

A greenish, basic dyke, 24 yards wide, runs up the face of the hill on the eastern side of the creek, and outcrops on top, on the south-western side of the saddle from which rises the precipitous peak of quartzite, already referred to. It is 20 yards wide at the top of the hill and throws out lateral dykes.

Higher up the creek the section shows rotten purple shales having a strike S. 20° W. with dip at 90°.

The country now becomes more or less reticulated with basic dykes, over a breadth of a quarter of a mile, or more. One very prominent dyke that intersects the creek is 25 yards wide, bordered by shales on the one side and quartzites on the other, which show contact metamorphism.

Followed up the main north-eastern creek for a while. In the alluvial of this and other creeks were pebbles of brecciated limestones, as well as "greenstones" derived from intrusive dykes. Crossing the low range, on the eastern side, basic dykes outcrop with a strike east and west. Further intrusive dykes were seen on the next range, 2 miles distant from the most westerly outcrops that were noted. Similar intrusions were observed crossing the old Blinman road in several places, in one case giving a width of 60 yards. The sedimentary rocks met with in this cross-country journey to Blinman were some prominent outcrops of quartzite, flaggy sediments, and small dolomitic limestones.

III. BLINMAN AND NEIGHBOURHOOD.

The Blinman township, according to official figures, is situated 2,020 ft. above sea level and 1,555 ft. above the Parachilna plain. The mine is in disturbed country, and the copper ores occur mostly in a dolomitic limestone near its junction with flaggy slates. These features can be well seen in the open cut where the limestone makes the foot wall and the slates the hanging wall. The dip varies from 65° to 75°. The captain in charge stated that the shaft cut the limestone at a depth of 50 fathoms and passed diagonally through it to the 70-fathom level. The ore in the upper part is in the form of copper carbonates and black oxide, which intersect the limestone by reticulation of large and small veins. The average width of the payable cupriferous zone is 14 ft. The ore sometimes lies in flat shoots, the thickest part of the shoot being from 1 to 2 in. The ore body seems to be limited by a cross-fault with an east and west strike on the southern side of the mine. From the nature of the ore distribution the whole of the mineralized country is worked as stockworks and smelted. As the ore is carried in limestone, ores of a siliceous nature are bought, when possible, for fluxing purposes, and sandy shales are also quarried and used for a similar purpose. [Since my visit the mine has been, unfortunately, closed.]

The hills on the eastern side of the Blinman Mine consist of shaly flags and crushed dolomitic rock. One hill, just east of the mine, exhibits a small syncline on its summit, best seen from the southern side: dip N. 65° E. at 75°, and S. 20° E at 60°. Half a mile to the northward of the mine is an igneous dyke, 18 yards wide, with a strike 20° S. of W. On the north side of the dyke there are strong flaggy quartzites that make a prominent hill and carry a thick band of lamellar hematite. A similar quartzite follows around the western side of the mine, and at a distance of one-eighth of a mile from the mine, in the same direction, there are strong beds of dolomitic limestone, much crushed, in association with igneous intrusions, of which there are three circular bosses (? chimneys), forming, by position, a triangle, about 100 yards distant from each other, each having a circumference of about 50 yards.

Crossed country to creek, on road to Parachilna, one mile east of Horne's Camp, and followed the road and creek back to Blinman. Laminated shales are seen in creek, on southern side of road, with a dip S.W. at 15° ; which suddenly increases, by a twist, to 73° ; and, further up, to 85 ; then swings around to E. 20° S. at 50°. Where the creek crosses the road the shales are intensely broken and reunited in large angular pieces. Following which, where the creek forms a loop on the southern side of the road, the shales, which are at first much shattered, pass into a synclinal fold with a high dip, and then to a lower angle with dip S. A succession of basic igneous dykes formed the chief feature for some distance on the same line of section. *First dyke* occurs at bend of the road in creek, on northern side, and is 40 yards wide with a dip of 85° W. The hanging wall to the dyke, on the western side, consists of laminated shales, that are not disturbed, having a dip S.W. at 45°. The dyke is underlain, on the eastern side, by shales which are greatly crushed and broken up. This broken rock shows an outcrop, up-creek, of 45 yards; then follow laminated, decomposed, yellow shales, with dip N.W. at 80° ; underlain by thinnish dolomitic rock, which is broken. *Second dyke*, situated 200 yards higher up than the first dyke (1½ miles from Horne's Camp). It is fine-grained and very basaltic like, is 60 yards wide, and a strike E. It is bordered by shales that are brecciated, with dip S. 20° W. at 83°. A little further on the road, a strong outcrop of quartzite is seen to come down the hill face on the western side of the road, but is cut off at the creek, and in its place, on the eastern side of the creek, is a fault rock, much broken for 30 yards, followed by dolomitic rock, with dip W. 20° N. at 75°. This, again, is followed by laminated quartzites, with dip N.E. at 60°; then swings around to N. *Third dyke*, situated about 2 miles from Horne's Camp, is 42 yards wide, with a strike W. 20° N., follows a small creek, and can be traced across larger creek, into hill, on the western side. *Fourth dyke*, situated about 200 yards beyond the third dyke, is 5 yards wide. There is a great show of crush rock on hill, on the eastern side, down to the road, consisting of shales and dolomitic rock in a mixed condition. For the next 200 yards on the road, shales and some dolomitic limestones occur. *Fifth dyke*, 2½ miles from Horne's Camp 120 yards wide. Junction of rock on southern side gives dip E. 20° N. at 65°. Two hundred yards further, blue limestone is seen on road, dip S.E. at 50°, with crushed dolomitic rock on top. Quartzites in shales, with dip N. at 45°, make a low rise in the ground. One and a quarter miles from Blinman there is a high and bold ridge of slaty dolomitic rock, somewhat broken in places, underlain by shales: dip S.W. at 80°. Last prominent ridge, on the eastern side of road, in a direction N. 20° E., consists of laminated shales, thin quartzites, and dolomitic rock in places. At one mile from Blinman are shales, dip S.W., with broken beds of slaty dolomitic rock. From this point the ground is low, undulating, and grassy.

IV. Blinman to Reap-hook Range.

Trip southward (4 miles) to Reap-hook Range. So called from its resemblance to the tool—a handle, and great curve for blade. Also known as Patterton Hill and Mount Emily. Drove out to Patterton Spring and then went one mile across to Reap-hook Range. The latter has a very striking rock face 500 ft. in height. The top beds consist of 25 ft. of impure arenaceous limestone having a vertical scarp· dip E. 25° S. at 5°. Beneath which is a steep scarp of purple shales and laminated flaggy shales. The latter are also seen at the Patterton Spring (mentioned above), where they dip S. 20° E. at 10°. In retracing my steps, on foot, from the Springs to Blinman, underlying the slates, just mentioned, is a dolomitic rock, then a limestone which weathers with a dark-coloured smooth surface, similar to the Archaeocyathinae limestone, but has arenaceous lines in relief that follow, generally, a circular outline; then an arenaceous limestone, showing an outcrop of about 100 yards, with dip at a low angle. A thin quartzite occurs in the limestone series, which is underlain, again, by thick arenaceous limestones; then ochreous limestone with vein of siderite. For the next half-mile there were noted calcareous beds, separated by thin beds of shale; then quartzites and calcareous grits: dip S.E. at 12°.

There follows a relatively flat country, in which shales are first met with, then solid limestone showing wavy structure and is sometimes arenaceous, which continues to small creek, three-quarters of a mile before reaching Youangera Spring. On the Blinman side of the creek another strong limestone is seen on a prominent rise, just before sharp bend in the road (between Sections 64 and 69), with shale on top and is underlain by quartzite, with a dip S.E. These beds are followed by a somewhat lower hill, consisting of flaggy shales; and then, strong calcareous grits passing into brecciated limestone, which latter makes a bold ridge that crosses a creek that is tributary to the Blinman Creek, about a quarter of a mile above the road crossing. Some fine springs occur in the creek a few yards above the crossing.

Soft shales are on the flat skirting the eastern side of the limestone range, just mentioned (dip E. 20° N.), and these are faulted against shales with thin beds of ferruginous limestones which dip S. 20° W. Both these sets of outcrops are at high angles, as seen on the flat, and are also much curved.

At the road crossing the tributary creek, near the Youangera Spring, flaggy shales dip E. 20° S., at from 40° to 45°. Here a very curious white limestone is seen resting unconformably on the shales. The limestone rolls a little, with anticlinal and synclinal curves, and is eroded where the curve passes above the normal level of the ground. It is compact, somewhat nodular, and includes numerous fragments of shale. It is veined with crystalline matter and has manganese oxide stains. The question as to its origin carries some doubt, but it is most probably a travertine limestone with certain unusual features. It is seen on the north side of the creek, and can be traced to the junction of the two creeks, a distance of about 100 yards, beyond which I did not continue my observations. The bed does not seem to rest on calcareous rocks; it is from 6 to 8 ft. in thickness limestones occur on the scarp face about one-eighth of a mile to the eastward. It seems probable that it is a travertine deposit laid down, at a somewhat distant period, by spring waters fed from the calcareous beds of the scarp that exists on the eastern side, perhaps before the scarp had retreated as far as at present. The creek that has cut its way through this peculiar limestone gives no evidence of carrying any quantity of calcium carbonate in solution at the present time. On the western side of the crossing, in the same creek, there are similar laminated shales as occur above the crossing and are dolomitic, in places: dip E. at 40°. There is also an overlying limestone, on this side, but it is not so developed or so compact as in the higher position in the creek, described above.

The road, after crossing the creek, has a trend more to the west and passes over a ridge of shales, sometimes calcareous, which pass under the limestones of the scarp, described above: dip S.E. at 50°. Beyond the last-named ridge, a 12-ft. bed of limestone occurs in the shales, followed by flaggy quartzites, which make a bold hill on the western side of the road: dip E. 20° S. at 75°, increasing to 90°. On the other side of the range—in lower ground—the rocks are somewhat broken and have an easterly dip.

Passing into the valley of the Blinman Creek, shales and flaggy quartzites form the outcrops, the quartzites carrying the fine dark lines similar to those seen in the quartzites on hill west of South Blinman, and also west of the Blinman Mine.

THE BLINMAN CREEK.

The Blinman Creek, near the townships of North and South Blinman, supplies exposures illustrating crush-rock to an extreme degree. The purple shales, particularly, are converted into crush-breccias and crush-conglomerates in which the original bedding is entirely obliterated, or is present only in isolated fragments. The locality is also greatly intersected by intrusive dykes.

Going south from South Blinman (in creek) the purple shales are overlain by flaggy shales: dip W. 10° S. at 80°.

(1) A great basic dyke crosses the creek forming a prominent ridge 30 ft. in height and 100 ft. in width. The dyke cuts across cupriferous flaggy shales, the latter having a dip of 70° W. of N. at 60°.

(2) Two hundred yards lower down the creek another dyke crosses the stream—on the eastern side, measuring 15 ft. in height and 90 ft. in width. On the southern side of the dyke purple shales form a cliff face in the creek and are intensely broken and brecciated. The dyke crosses to the western side, where it is seen on the rise of the hill. The strike is N.E., and follows along the slack ground.

(3) On the western side of the creek, about midway between the two dykes just referred to, is a circular outcrop of igneous rock, 100 yards in circumference. The stone is scoriaceous, in parts; whether the vesicular structure is due to gas cavities, or spaces left by the decomposition and removal of included crystals, is not quite clear, but the cavities have been subsequently filled, in some instances, with $Fe\ CO_3$ and other crystals. The circular outline of the outcrop suggests the possibility of its being an old volcanic "neck."

The prominent hill that is on the western side of South Blinman has quartzites at its summit, and, for the most part, on its southern face also: dip 10° S. of W. at 75°. The quartzite carries dark lines (a common feature in the quartzites of the Upper Cambrian series), and there is also a dolomitic limestone, much contorted and irregular, that outcrops on the southern and south-eastern flanks of the same hill. The dolomitic bed has a rolling strike of N.W. and S.E.

A ridge of hills runs parallel with the road between South Blinman and North Blinman, on the eastern side, consisting of flaggy shales and quartzites, with dip N.E. at 75°.

Following the Blinman Creek to North Blinman, a great development of crush-rock occurs both in the creek and on the flanks of the low ranges on the western side. The rocks consist of siliceous shales and thin dolomitic limestones, in which the strike and dip vary with every few yards, from horizontal to vertical, the dip tending east and west. From the Government well, situated in the creek, the beds become more regular (going north), the siliceous shales showing a dip N.E. at 50°.

On the bank of the creek are some very large spheroidal masses of siliceous quartzites, and these occur again, higher up the creek, containing dark lines, and have a dip N. 20° W. at 45°. This spheroidal weathering in homogeneous siliceous rocks, as well as the dark lines, often cross-bedded, are very characteristic features of the Upper Cambrian beds of the Flinders Range.

V. TRIP FIVE MILES NORTH OF BLINMAN.

Followed the road on the eastern side of the mine, which passes over a flat and trends in a north-westerly direction. Dr. Lander drove me to Little Willigon Creek, which is separated from the Willigon by a ridge, at about 5 miles from Blinman. Left the conveyance and proceeded on foot. The Little Willigon Creek cuts through the ridge mentioned, in a small gorge, with shales on the one side and limestone on the other. The limestone, which makes the ridge, at the gorge, shows a structure of concentric lines like globules 1 in. to 2 in. in diameter, which weather into depressions, it has also inclusions of shale in angular fragments. It is underlain by flaggy shales that dip N. at 35°.

By climbing the ridge between the Little Willigon Creek and the main Willigon Creek (a distance of about three-quarters of a mile), from its highest point the geological structure of the country could be well seen. An imposing range on the north side (4 miles distant) marks the limit of vision in that direction with a steep scarp face on the southern side, apparently composed of flaggy shales with interbedded impure limestones. Then followed an inner range of rounded hills covered with green feed, approximately 2 miles wide. From the physical features I concluded that this area was composed of purple shales. Another range, at a shorter distance, occupied the space down to near the Willigon Creek, and showed a steep face to the southward composed of flags and thin limestones. All these outcrops to the north of the creek could be distinctly seen to dip northwards, giving a section of 4 miles in diameter.

On the southern side of Willigon Creek there is a succession of hills increasing in altitude towards Blinman, consisting chiefly of impure limestones with some flaggy shales. About one mile from the gorge of the Little Willigon Creek the road crosses a small tributary of the latter in which limestones make a great development on the northern part of the hill, with a dip N. 20° E. at 23°. The limestone has a concretionary structure and is very brittle with a spheroidal fracture. The limestone is underlain by shaly flags. At a quarter of a mile further the road crosses the tributary stream again, at a bar formed by another limestone that is impure, carrying streaky lines and reticulations of an earthy nature, in relief, as well as small stones. This limestone outcrop is 53 yards wide, with a dip N. 20° E. at 30°. Within a few yards it is followed by another limestone, quite as thick as the preceding, and forms a scarp face which runs parallel to the stream and road for 1½ miles; the road then takes a southerly turn.

On the southern side of the great limestone series there follow, in descending order, a thick series of flaggy shales with ferruginous dolomitic limestones and grits in prominent edges ([?] 2 miles across the strike). The road rises to a high point, where the shales dip N. 20° E. at 30°, and are overlain by grits and a ferruginous dolomitic rock.

Coming down the hill on its eastern side the strike swings round a little, with a dip N.E. at 25°, which has the effect of bringing the limestone once more across the road, where the latter crosses a large creek. The road continues on the line of junction between the limestone and shales for over a mile. The road crosses the creek for the last time, where the shales have the same dip as in the last reading, *viz.*, N.E. at 25°.

The road now curves round to the south towards Blinman. Flaggy shales continue on low ground. About one and a half miles from the Blinman Mine, situated near the road, in a small wash, there are gritty rocks, much broken and twisted, in an apparently vertical position, and, mixed with these broken beds, is a deposit of small quartz crystals, separately developed, making a width of 10 yards, and extends still further in patches.

About a mile from the Blinman Mine, on the western side of the road, there is a great spread of gritty limestones on the flat, making an outcrop 200 yards in width, underlain by flaggy shales, best seen on the rise of the hill, having a dip N. 30° E. at 25°. The same shales are seen in the creek on the eastern side of the rise, with a dip N.E. at 27°. The gritty limestone, just referred to, appears to be cut off by a strike fault on the eastern side and is probably a repetition of the limestone of the range seen to the north. The disturbed strata in the valley (referred to above) may be regarded as suggestive of such a fault. The associated shales pass up into quartzitic rocks on the rise, with shales on the other side in a much disturbed condition: dip S. 20° E. at from 40° to 50°.

On the next flat (and, apparently, on the rise to the west) there is a thick limestone with concentric structure, in an outcrop of about 200 yards. This bed is underlain by rotten shales, seen in a small quarry on the top of the rise on the road, above the township, with a dip N. at 45°. On going down the slope to Blinman there are evidences of dolomitic limestones, which probably may be correlated with a similar bed at the mine.

VI. Trip to Patawarta Hill.

Patawarta, as seen from Blinman, looking northwards, has the appearance of a great wedge-shaped pinnacle, rising conspicuously above all the surrounding hills, being the highest point of a bold range of quartzite having its scarp face to the south and dip slope to the north. Mr. J. V. Whyte, of Angorigina Station, kindly drove me out a distance of 12 miles to visit this interesting hill, which official Survey Reports state to be 3,060 ft. in height.

The road lay through the Nildottie Gap, up the valley of the Artimore Creek, past Artimore Head Station, and over the shoulder of the Patawarta Hill, on its western side. The journey took in country seen to the north on my trip to the Willigon Creek.

At the base of the hill, on its southern (scarped) side, there are calcareous shales and thin limestones, in vertical position, having a strike E. 20° N. Thin beds of quartzite follow, divided by partings, or thin beds of purple shales, with gradually lowering dip, at 85°, 75°, 65°, 45° N., a few degrees E. The hill itself is a mountain of almost solid quartzite, which, near the summit, has a dip N. 10° E. at 23°. The stone is softish to hard, siliceous, and, in colour, white to reddish. About half-way up, the quartzite contains a number of siliceous concretions, in the form of balls, ranging in size from that of marbles up to cricket balls. These have a rounded or flattened shape, sometimes possessing an equatorial ring, and are harder than the matrix in which they occur. The great hill is almost bare of vegetation (see Howchin's "Geology of South Australia," fig. 49, p. 66).

A course was followed over the western shoulder of the hill and through a gorge on its northern side, where the quartzite showed a dip N. 10° W. at 27°. The path was followed for about 2 miles over the saddle and through the foot hills on its northern side. A magnificent view of the country lying to the north was obtained from this vantage ground. Immediately in front was a flat, about 2½ miles in width, drained by the Molkegna Creek, that takes its rise in the Patawarta Range. Beyond this river valley is a relatively level tableland into which the Molkegna Creek has cut, giving the tableland a steep scarp on its southern limits. The scarp shows dark-coloured beds at the top and shaly beds beneath. In outline, this scarp face very much resembles the "Reaphook" Range (or Patterton Hill) to the southward of Blinman, and carries the same name from its peculiar shape.

Still further north, at a distance of 12 miles from Patawarta, the southern portions of the Angepena system of hills were in view. They form a remarkable circle, 8 miles in diameter, the dip of the rock being towards the centre of the area, forming a "pound," similar to the Wilpena Pound. Several creeks take their rise within the enclosed area, uniting to form the Waukawoodna Creek, which finds its outlet at the Waukawoodna Gap.

The Patawarta Range appears to be greatly disturbed near the great hill The dip on the southern side is vertical, while on the eastern side the range is broken, forming a jumble which passes into a bifurcation of the range; the northern section running east, with a few degrees south, to Point Well (on Point Creek), a distance of 6 miles, where it abruptly ends at Ann's ("Trig.") Hill. The southern branch trends in a south-easterly direction, and when, at about the same distance east as the northern branch, by a swing round to the southward, it converges to the nearly parallel Nildottie Range (or The Bunkers), so that the two ranges, at the point of convergence, are only separated by the Nildottie Gap through which the Artimore Creek passes. On the western side of Patawarta, the range curves round to the north-west, and then to the north-east, including Mount Tilley and Mount Hack, both of which are "trig." hills, and continues to Angipena Head Station, a distance of 20 miles or further. The Artimore valley widens out from the "gap" in a north-westerly direction, until due south from Patawarta, where it is 2 miles wide. The interval separating the Nildottie (Bunkers) and Patawarta Ranges is occupied by flags, calcareous shales, and thin limestones, with dips from E. to N.E. At the Artimore Head Station, situated within half a mile of the big Nildottie Ranges, outcrops show flags and purple shales with a dip N.E. at 30°.

For several miles, on the return track, the course was along the strike of the purple shales, along the Artimore Creek, with the Nildottie Range on the southern side and the southern branch of the Patawarta Range on the northern. The former possesses very striking features —it has a dip slope of hard quartzite on its northern side, dipping slightly E. of N. at 45°-50°. This hard back is underlain by softer beds, which, by weathering, cause a nick in the summit, and is followed by another hard quartzite bed, at a somewhat oblique angle to the range, which makes a second peak, followed by softer beds with a second nick at the summit. By these alternating hard and soft beds placed on the oblique the range is cut down, at intervals, to about half its height, forming a succession of house-roof structures, giving the range the appearance of the teeth of a gigantic saw. The supposed resemblance of the depressed area between the peaks to a succession of "bunks" has suggested the name "Bunkers." Mount Lucius, a "trig." hill, is the highest point of the range.

On the southern side of the Nildottie Range, the hills have a rounded form from the weathering of purple shales; they are free from trees but covered with herbage. A little further to the north-west, in the neighbourhood of the Willigon Creek (mentioned above), the quartzites form the southern side of the range and make a great southern escarpment. At the Nildottie Gap, where the two ranges converge, the rocks are much broken, with very steep dip slopes on the Nildottie Range, to the eastward, and a throw-up of calcareous beds between the converging ranges. There has been a contraction of the earth mass, producing folding of the valley beds and the bringing together of the two ranges at the "gap," which has been kept open by the erosive action of the Artimore Creek. Strong limestones outcrop in the Angorigina Creek on the eastern side of Blinman.

VII. WESTERN SIDE OF BLINMAN.

About 1 mile from the mine, on the more northern road from Blinman to Parachilna, there is an outcrop of gneissic granite in large rounded boulders, and on the western side of the granite is a wide basic igneous dyke. Other basic intrusions are seen at intervals going west.

About 2½ miles from the mine is another outcrop of granite, in large spheroidal boulders, and a basic dyke, running east and west, apparently as a continuation of the same line of igneous activity as that mentioned in the previous paragraph. The associated rocks are greatly altered. Close to the granite is a broken and altered dolomitic bed, which is intimately permeated with hematite and a little copper.

About a mile (or little more) to the south-west of the above outcrops is a very large deposit of lamellar hematite (specular iron) in beautiful crystals mixed with siderite. The adjoining country rock consists of dolomitic limestones and flags.

As the high range, which runs in a south-west and north-east direction, is approached, foot hills consisting of dolomitic rock and quartzite flags are met with, forming the mouth of the gorge, and basic igneous dykes are seen on both sides of the road, averaging a distance of about a quarter of a mile apart. The one on the southern side of the road makes a prominent outcrop, about 30 ft in width, but soon either runs out or is obscured by surface drift. The other, on the northern side of the road, is about 25 yards wide and strikes N. 20° W., and, at half a mile, crosses the road. Shortly before this it appears to bifurcate, the two branches with the sedimentary interval having a width of about 100 yards. Shortly before reaching the road it crosses a small creek, near a dolomitic limestone which has a breadth of outcrop of 6 yards, and is much altered by contact with the dyke.

The gap in the ranges is about 4½ miles from Blinman. The first definite range is composed entirely of quartzite, which, on weathering, breaks up into flags: dip N. 20° W. at 65°. Mount Elkington is the highest point in this range. The next range, in the same gap, at a distance of 5 miles from Blinman, is more flaggy, with a dip N. 10° E. at 55°.

VIII. SOUTH BLINMAN AND ROAD TO WIRREALPA.

At a half-mile distance from South Blinman there is a low outcrop, on the right hand, consisting of flagstones with similar rocks forming a prominent range on the left, with a considerable discordance of dip in relation to each other. The beds on the right-hand side of the road show a dip S.E. at 55°, and are overlain by thick dolomitic limestones; while those on the left hand make escarpments, facing the west, at a dip N. 70° E. at 35°, and have a gradual slope to the east.

Beyond this range, to the eastward, is a considerable plain, 2 miles across, with numerous outcrops of dolomitic rock, interspersed with shales, apparently flat, and even with the ground, or nearly so. The variations of outcrops on the plain are as follow:—Near the last-mentioned range, at its eastern base, are thick limestones almost even with the ground. At 1 mile from the range there are limestones that show a kind of pseudo-vermiculate structure, with a dip of 15° E. At the end of the next half-mile is a ridge, 20 ft. to 30 ft. in height, consisting of limestones with oolitic structure, and includes some sandstone bands: dip E. 25° S. at 10°. For about another mile the road is on purple shales that form low exposures, the road following very nearly the line of strike.

The road passes into Paddy's Creek, at the head of which are flagstones and shales, with a dip of 17°.

At 3 miles from South Blinman, dolomitic limestones can be seen on top of range, on the left hand, which pass down to level and cross the creek.

At 4 miles from South Blinman, in Paddy's Creek, a very thick and confused mass of dolomitic limestones and shales come down from the ridge to the creek, the two kinds of stone being crushed together: dip 55° to 90°. These are overlain by soft shales that are greatly contorted. Next follow thin quartzites separated by shale partings: dip E 10° N. at 45°.

At 5 miles distance, a hill on the north side of the creek, about 300 ft. in height, consists of dolomitic beds, in part crushed. Shales occupy the opposite side of the creek: dip E. at 50°.

At one-eighth of a mile further, a quartzite bar crosses the creek and forms escarpments on each side of the creek at a spot where the road finally leaves Paddy's Creek. In the creek are seen indurated shales, with dip N E. at 60°, while flaggy shales that show on the hill above, and overlie those seen in the creek, have a dip to S.E at a low angle. This discordance is probably caused by faulting.

For the next 2 miles the road follows the strike of purple shales, and a great development of these shales is seen in ranges to the southward, while to the northward the view is bounded by great escarpments of quartzite.

At the 7-mile stage, the purple shales are still in evidence (dip N. at 55°), and the road continues on the strike of these beds almost to the Erengunda Creek.

At 9½ miles from South Blinman, the purple shales, on the southern side of the road, have a dip of 85°, and are faulted.

Within a quarter of a mile of Erengunda Creek there is a thick dolomitic bed (not much above the general level), then follow purple sandstones (dip N. 65° E. at 45°), which rise into a high escarpment on the eastern side of the road (? 500 ft.). This is probably the same bed which makes bold escarpments seen on the northern side of the purple shales, as described above.

On the northern side of the purple sandstones there is a very thick series of limestones, forming a low range on the southern side of the above-mentioned creek, 90 yards wide, and includes a great variety of dolomitic rocks. The creek has cut its way through these limestones (dip 80° E. of N. at 55°), which cover the whole width of the creek (probably 100 yards), and extend to 38 yards beyond, on the northern side, where they are overlain by calcareous shales.

On the Wirrealpa side of the Erengunda Creek is the

"Half-way Hill" (otherwise called the "Big Hill"). At 200 yards up this hill there is a quarry in shales that exhibit a small syncline, or kink, in the beds, ending in a dip at 20°. Half-way up the hill the beds consist of thin dolomitic limestones, separated by earthy partings, the latter being indurated by cementation show differential weathering, and stand out from the limestones in relief: dip N.E. at 40°. In the upper part of the hill, on the road, the dolomitic beds become thicker and are separated by shaly partings: dip N. 10° E. at 42°. Near the top of the series are Archaeocyathinae beds.

Quartzites are on the northern side of the great dolomitic belt, and these are succeeded and intercalated with more dolomitic beds.

[For descriptions of the section from the "Big Hill" to Wirrealpa, see under Section XV., as that part of the journey was made from Wirrealpa.]

IX. WIRREALPA AND NEIGHBOURHOOD.

The Wirrealpa Head Station stands on purple sandstone flags which underlie a series of thin-bedded limestones. The general strike of the country is north-easterly, with a south-easterly dip. Behind the station house, soft decomposing flags can be seen in the small creek, with a dip E. 20° S. at 70°, the beds making a curve round at the homestead. Within a short distance of the house, bands of oolitic limestone occur in calcareous and sandy shales. These bands are of much interest, as they include layers, up to a few inches in thickness, of broken and thickly-matted shells of *Obolella,* Pteropods, and Trilobites. These beds have every appearance of being shore deposits, their oolitic structure and the fragmentary condition of the organic remains, closely matted together, all point in that direction. Associated with the same beds are some very fine-grained and laminated sandy layers, which show worm burrows and casts; the burrows are in the form of vertical tube-like passages, while the worm-casts are seen on the flat surfaces of the slabs: dip S. 20° E. at 70°. At a slightly lower position in the series is a remarkable layer of limestone, up to 6 in. in thickness, which is thickly crowded with flattened and spheroidal nodules of *Girvanella,* up to an inch and more in diameter. Their determination was made by thin microscope sections by which the typical structure of this organism was shown. Some of the nodules thus examined, however, failed to give a clear definition of structure; the very minute form of the tubes had, by molecular rearrangement, become more or less blended with the matrix.

A stronger bed of limestone, 10 ft. in thickness, underlies the fossiliferous beds, just mentioned, and makes a low ridge that can be followed by the eye for a long distance. The limestone has undergone differential weathering from the presence of siliceous material which shows in relief as blotches, casts, and reticulations of an arenaceous character No organic structure could be detected in these objects in relief, but some of them strongly suggested casts of Pteropods and other organisms. The limestone is laminated at some levels and is subnodular. Near the homestead, on its northern side, the bed has a dip to the S.E., from which point it gradually curves round to the S., then S.W., then W. 20° S. at 20°, then W. 20° N. at 40°, from which point it makes a strike, for about a mile, parallel with the eastern side of the old road, then makes a sharp twist in the form of the letter S. At 1½ miles from the homestead, at a small creek where the road makes a sharp turn to the north, the beds dip W. 20° S. at 80°. About 100 yards from this point the beds are cut by a dip fault and the purple flags are thrown against the faulted face The purple shales dip S 20° W. at 65°. The limestone is thrown 53 yards to the S.W., when the dip is S. 20° W. at 70°. On the southern side, the oolitic limestones and *Girvanella* bed that occur near the Wirrealpa homestead, show on the rise, with a dip W. 20° N. at 65°. These overlying beds are evidently faulted against the lower, as the strike is divergent. On the low rise situated between the small creek and a larger one, at this point, a great number of fragments of the Archaeocyathinae limestone occur, no doubt brought down with the alluvium of the creeks.

X. UP A TRIBUTARY OF WIRREALPA CREEK.

The main creek passes the station house on its south-eastern side, the bed of which is thickly strewn with boulders and gravel. Near the bottom end of small creek that is a tributary to the Wirrealpa Creek, on the western side of the "Trig" Hill, bleached and rotten purple shales have a dip of 90°. In going up the creek the dip decreases. A few hundreds of yards up, shelving purple sandstones, etc., are seen in quarry, with a dip S. at 23°. Massive purple sandstones dip S.W. at 18°. Higher up, where the creek bifurcates, the right-hand branch exposes a 15-in. bluish limestone and a 3-ft. earthy limestone, with a shale bed between: dip W.N.W. at 34°. At 300 yards up the left-hand branch there is a bar of limestone with wavy and concentric structure having a dip W.N.W. About a quarter of a mile up this creek, several large loose stones, up to 2 ft. in diameter, containing Archaeocyathinae remains, rest on a bar of limestone, but the latter does not appear to contain similar remains.

At half a mile up this creek a thick limestone with wavy structure occurs (dip W. 10° S.), and is overlain by purple shales. The latter are overlain by other thick wavy limestones that form a prominent hill and cross the creek near a group of gum trees; the dip in creek is S.W. At 300 yards further up another bed of wavy limestone crosses the creek, near the centre of which a large block of blue limestone (3ft. in length) thickly studded with Archaeocyathinae rested, but it had no stratigraphical relationship with the bed *in situ*. Overlying the last-named limestone are more purple shales, and, by folding, the same wavy limestone, underlying the purple shales, is brought into the creek again, higher up.

The creek in which the above observations were made is a small tributary of the main Wirrealpa Creek, which latter passes close by the Wirrealpa Head Station, and according to the pastoral map, is a continuation of the Artimore Creek, which takes its rise at the Patawarta Hill. Numerous loose examples of the Archaeocyathinae limestone were observed both in the wash of the small creek and on the shelving banks that bordered the creek. While I could not locate the parent rock, they are, possibly, local in their origin, as the creek in which they occur is only about 2 miles in length. They may have been derived from some of the thinnish beds of limestone that cross the creek, and which are much broken up, or, possibly, from the main Archaeocyathinae limestone further afield. The country, for miles around, is composed of purple shales, sandstones, and limestones. One piece of fossiliferous rock picked up in the creek was composed almost entirely of long lath-like organisms, the nature of which has not been determined. The creek will well repay further investigation.

XI. The Obolella Limestone on the Road to the Old Wirrealpa Station.

Followed the Blinman road for half a mile to the junction of the track leading to the old Wirrealpa station buildings, passing over purple shales, with dip W. 20° N. Following the old road over the first rise (low), flags outcropped, with a dip W. at 33°. Second low rise, thin impure limestones (dip W.) that are neither oolitic nor fossiliferous. Several such thin-bedded impure limestones occur interbedded with the purple shales and arenaceous flags. The strike becomes S. 20° W. (dip W. 20° N.). The road crosses a tributary of the Wirrealpa Creek in which good sections of purple shales and flags are seen: dip N.W. at 30°. In a low rise to the westward of this creek impure streaky limestones occur. In a second small tributary (east of the high rise) calcareous flags strike W. 20° S. (dip S. 20° E. at 25°), and as the road rises above the valley a distinct fault line can be seen on the road that has the effect of splitting the purple shales which dip at a high angle: strike of fault W. 10° S. A little further on flags are seen in a washout: dip S. 20° E. at 35°.

At about 2½ miles from the Wirrealpa Station, a considerable rise of flaggy quartzites occurs, in which is situated the Wirrealpa Copper Mine. The mine, which is a small and new venture, is a bedded lode of shale, 2 ft. in width, lying between two beds of quartzite, each being about a foot in thickness: strike W. 10° S. (dip S. 10° E. at 40°). Over the rise in which the copper mine is situated the country gets a twist in which flags strike S. 20° E. (dip W. 20° S. at 28°). This rise forms a bold scarp to the west, at three-quarters o" a mile distant, where the beds are seen to gradually swing round to the strike and dip last quoted.

On the top of the next rise on the road, 3½ miles from the present station house, the fossiliferous (*Obollela*) limestone occurs. It is evidently the same bed as that which carries *Obolella* in such numbers near the head station. The limestone is about 5 ft. in thickness and is more solid than the outcrops near the house. The fossils are found mostly in the upper portions of the bed and are rare in the lower portions. The rock is almost completely oolitic in structure, and while it carries a diversity of organic remains it is particularly characterized by the presence of the brachiopod *Obolella*. Slabs can be got which are formed by one mass of the valves of this shell: strike of the bed W 20° S. (dip S. 20° E. at 15°).

About 150 yards across the valley, to the northward, another limestone makes a prominent outcrop. This is the limestone which accompanies the *Obolella* limestone near the head station. It is known as the "ridge" limestone, or the "5-mile ridge," as it makes a prominent feature across the country for 5 or 6 miles. This ridge limestone and the *Obolella* limestone cut the road at a right angle.

Following the fossiliferous limestone westward, the beds cross the Wirrealpa Creek within a few hundred yards of the road, with a strike W. 20° S. and dip S. 20° E. at 20°. Shortly after crossing the great creek the beds swing round sharply to S. 20° W. and dip E. 20° S., passing under the escarpment of red sandstone, mentioned above, which is the same range in which the copper mine is situated.

Returning to the road I followed the outcrops of the fossiliferous beds in an easterly direction. Here the dip swings round to the south, then S. 20° W., then S.W. at 23°.

At about half a mile from the road the ridge is suddenly broken and twisted over a distance of 150 yards, when the beds again form a ridge as an isolated hill: strike N. 20° W. (dip W. 20° S. at 28°). The ridge is maintained for about 200 yards, when it ends abruptly—cut by a fault—while the limestones are thrown at nearly right angles to their former direction: strike E. 10° S. (dip at 35°). So far as the beds could be followed, by sight, they continue on the same strike; then, at a mile distant, they appear to curve round towards the east, or some point south of east.

Starting again from the *Obolella* bed that crosses the road to the old station, 3½ miles from the present Wirrealpa Station, going north, a limestone ridge forms the foot hills of the main escarpment range, and has its strike in the direction of the old station, and appears to be faulted. A very much brecciated limestone occurs between this ridge and the great Archaeocyathinae limestone which outcrops in the creek, a little higher up, where it is exposed in great spheroidal masses The brecciated limestone (which shows bedding planes) has a dip W S W at 50°, and contains angular fragments of purple quartzites, etc

XII. The Old Wirrealpa Station.

At the old Wirrealpa station (7 miles north of the present station) there is a great show of the Archaeocythinae limestone series, making 100 yards of outcrop: dip W.S.W. at 55°. There is an extraordinary break up of the rocks which are seen in the Wirrealpa Pass. The great quartzite range, which forms a high peak at Wirrealpa Hill, comes to an abrupt end near the old station buildings, and the beds in the valley, as well as much of the thick limestone on the opposite side, have been reduced to a breccia. Towards the centre of the valley the beds are mostly quartzitic, and are so crushed that they form a fault rock of great width. The great quartzite hill disappears—cut off by a fault—on the north-eastern side of the station; the limestone on the opposite side of the valley forms a conspicuous peak, which can be seen from a great distance.

At the old station the beds dip to the S.W. Following up the creek the beds make a curve. At half a mile distance they dip W. 10° S. at 35°; then a little further, the limestone gives a reading of W. 20° S. at 75°, which has the appearance of being almost at right angles to the dip of a conspicuous hill (marked "First Hill" on map), with limestone near its summit, situated in a direction to the S.S.W. As near as could be determined, the beds of this distant hill have a dip W. 20° N. at 40°.

The country gives every evidence of great and conflicting earth movements. The Wirrealpa Hill, which forms the terminal point of the Mount Lyall Range (which extends in a north-easterly direction), is the exact counterpart of the Parachilna quartzite escarpment. The dip of this hill is also on the curve. The southern side of its termination dips south-west; whilst, on the opposite side, the dip is W. 20° N. The Archaeocyathinae limestone overlies the quartzite at the base of the hill (as it also does in the Parachilna Gorge): dip in the centre of the curve is W. at 15°. The last exposure of the quartzite, in the big creek, on its eastern side, has a dip S.W. at 40°.

The Archaeocyathinae beds have some features of special interest. In one part the rock is of a light colour and very pure, and although the larger forms of organic remains are somewhat scarce at this horizon, those that are there are well preserved, and the rock mass is largely made up of small sponge spicules, which can only be detected in microscope preparations and do not admit of further determination.

XIII. Visit to Mount Chambers Creek.

Mount Chambers is an important "trig." hill situated about 23 miles to the south-eastward of Wirrealpa. The intervening country is mostly low. Mount Chambers Creek comes in from the north-west and penetrates the mount, where it makes a bold and rugged gorge with nearly vertical faces. The mount has a limestone cap, formed into a shallow syncline. The limestone is somewhat impure, resting on purple shales, which show a sudden increase of dip. A fault is probably present, as the rocks, extending over a large outcrop, are in the condition of breccia. In one of the outcrops the shales have a bluish colour: dip W.N.W. at 27°. The limestone underlies thick purple quartzites, which can be seen in the gorge, and also in a small tributary creek that flows into Chambers Creek. In this small tributary there is a remarkable amphitheatre in the rocks, almost hid from view, in which is a spring of good water, and the walls, above the height where a man could reach, are well covered with native drawings, cut into the rock faces: dip W.N.W. at 24°. At a lower stage in Chambers Creek, about 2 miles lower down than Mount Chambers, is an important outcrop of the Archaeocyathinae limestone.

XIV. Mount Lyall.

Travelling from the present Wirrealpa Head Station, by the Tea-tree Well road, at half a mile distant beyond the gate which admits to the Woolly Paddock, a small limestone is exposed; it has a laminated structure and is undergoing change to manganic and ferric oxides; dip S. 10° W. at 30°.

The Mount Lyall Range extends from the old station, in a north-easterly direction, for a distance of about 3 miles. At Mount Lyall (fig. 2) it forms a sharp angle with a range that comes down from the north. At the angle is a prominent hill, about 150 ft. in height, which shows a scarp face to the south-east. This hill is a solid mass of limestone, brownish in colour, dolomitic, and very compact. The section represents the lower beds of the Archaeocyathinae series. These beds follow the strike of the northern range of hills, but they appear to run out to the northward. It is probable that the scarp face of the hill is a fault plane. The hill just mentioned has a dip at the summit N. 10° E. at 15°. From the top of the hill it could be seen that the beds on the north side of Mount Lyall were much disturbed, dipping at various angles both to the Mount Lyall Range and also to one another.

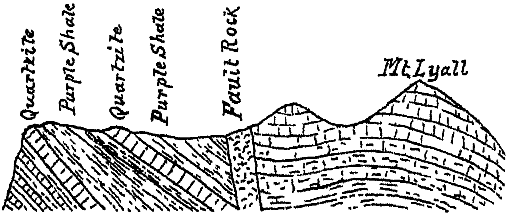

Fig. 2. Geological Section of Mount Lyall.

The peak of Mount Lyall dips N.W. at 60°. The north-eastern end of the range is broken by (?) two faults. Mount Lyall peak dips as above, then on the eastern side the dip somewhat suddenly changes to nearly horizontal. After a few hundred yards at this level there is a sudden break, when the purple shales, much crumpled, are thrown down to the face of the quartzites with a dip N. 20° W. at 35°. A crush-zone occupies the fault area for a thickness of about 9 yards. A series of underlying dolomitic limestones, purple shales, and quartzites follow with a rising dip, going east, to 50° (see fig. 2). Just round the northern end of the range there is an oblong dyke of intrusive rock. On the eastern side of the dyke there is a crush-rock, composed of flaggy shales, of considerable extent. This is probably on the line of fault, noted above, that cuts through the north-eastern part of the range.

There are low exposures of the Archaeocyathinae limestone, in the form of a fragment (probably limited by two fault planes), with a strike W. 20° S., and this is cut off by a fault that throws the quartzites against the limestone in an oblique line. Nearer the foot of the range the lower beds of limestone in the series occur, having a dip N 20° E. at about 25°.

A little south of this, cut off by faulting, is a small quarry in which the decomposed sandstone is seen, on one side, having a dip W. 10° N. at 15°, and is thrown down, on the eastern side of the quarry, with a dip E. 20° N. at 75°. The strike of the fault, which cut off the Archaeocyathinae limestone, seems to have a bearing W. 20° N. The end of the limestone, where faulted, shows metasomatic change to iron and manganese oxides. On the western side of the fault are purple shales (greatly contorted), thin limestones, and flags.

The general section of the Mount Lyall Range closely resembles that seen in the Parachilna Gorge, but is more disturbed than the latter

XV. FROM WIRREALPA TO THE "BIG HILL"(4) ON THE ROAD TO BLINMAN.

At 4 miles out from the station (after having passed over a flat of purple shales and flags, with an occasional thin bed of impure limestone), the red sandstone of the scarp hill, near the Wirrealpa Creek, comes down to the flat and crosses the road: dip S. at 15°. The road runs on the strike of these beds for a mile, then the sandstones swing round to south-east, with an increase in the angle of dip, and are underlain by a series of limestone bands that have an oolitic structure, which measure, in the creek and sides, about 50 yards of outcrop: dip E. 20° S. at 80°. These oolitic limestones are the same as have been spoken of above as the *Obolella* limestones. Within a few yards they are followed by the "ridge" limestone, which forms a kind of rampart 12 ft. high: dip E. 20° S. at 65°. On the northern side of these beds, there are soft decomposed flags and shales, which are perpendicular, or, for a few yards, reversed, to W. 20° N., with a decreasing dip, and then back again to easterly. A creek runs in the form of a loop between these outcrops.

At 6 miles out from the station there are two conical hills, situated on the western side of the road, which are either igneous dykes, chimneys, or (?) sheets. The highest is probably 300 ft. in height, and consists of a dark-coloured basic rock; but whilst it passes to the top of the adjoining hill, separated by a deep and narrow valley, no continuity can be traced between the two intrusions. Indeed, stratified beds of limestone and decomposed shales can be traced almost uninterruptedly across the dividing area. The beds are much disturbed in their strike and angles of dip adjacent to the igneous rock. There is a curious, and not easily explained, relation between the igneous rock and the sedimentary deposits. A limestone appears to go up to the centre of the igneous dyke (or (?) sheet), in the centre of the line of strike. The limestone has a dip E. at 70°, whilst the strike of the igneous rock is N.E.

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(4) This is quite distinct from the "Big Hill" which occurs between Parachilna and Blinman although known, locally, by the same name.

Separated by a belt of rotten shales and quartzite flags, 100 yards in width, is another igneous dyke (or (?) sheet), near to the road. Its composition is very distinct from those previously mentioned, although on about the same line of strike. At the north-east side of the hill there is a bold outcrop of rock consisting of limestone and shale, closely adjacent to the igneous rock.

Following these igneous outcrops, in a westerly direction, is Sandalwood Flat, about 1 mile in length, in which the rocks continue mostly on the same line of strike. At the northern end of Sandalwood Flat, and on the same side of the road as the preceding, another igneous rock is seen in a steep cliff in a creek. It has the same strike (N.E.) as the smaller igneous hill, next the road, described above, and possesses a similar rock texture.

A second ridge, on the westward, rises to about 300 ft. in height. The lower half of the hill consists of a hard laminated and dark-lined quartzite: strike E. 20° S. at 90°. The upper half of the ridge is a very close-grained igneous rock, with features distinct from the two other varieties already mentioned.

Near the base of the "Big Hill," on its eastern side, an important basic igneous dyke is exposed on the road. Its strike is, apparently, north and south, and is 34 yards wide. It occurs in dolomitic limestone, which latter is somewhat altered by contact with the intrusive dyke, and contains some copper ores, as well as a very large mass of ferrugineous and copper-stained quartz.

There are thus five important igneous intrusions near together and adjacent to the road on the Wirrealpa side of the "Big Hill." I very much regretted that no opportunity presented itself for making a more detailed examination of this very interesting igneous field.

As the "Big Hill" is approached from the eastern side, thick limestones appear on the eastern side of the road: dip E. 20° N. at 15°. A sandstone occurs in the creek, with a dip W. 20° S. at 55°. It is, apparently, included in the thick limestones, or, possibly, is nipped in by a fault, the beds seem to bifurcate about the spot. The limestone exposed on the eastern side of the road has the appearance of a shallow syncline. The great mass of limestone that forms the main part of the "Big Hill" comes up from the Erengunda Creek (see under Section VIII.). In its purest portions it forms a white and grey marble (dip N. 30° E. at 30°), with remains of Archaeocyathinae. The best fossiliferous horizon is in the upper beds, near the public road.

[The observations at this point join on to those given in the traverse from Blinman to the "Big Hill," in Section VIII.]

XVI. VISIT TO THE GRINDSTONE RANGE, BALCORACANA CREEK, AND THE WILKAWILLINA GORGE.

This trip was in a southerly and south-westerly direction from Wirrealpa Station. Going in a south-westerly direction, the track was over flaggy sandstones. At 1 mile distant, in small creek, soft sandy flags were exposed, showing false bedding: dip W. at 25°. At 3 miles out, descending to a valley (three-quarters of a mile in width), the exposures were still sandy flags, much false bedded. dip E. 20° S. at 35°. In a dry creek, near the centre of the valley, sandstone and flags have a dip E. 20° N at 35°. After crossing the valley and ascending a small rise, I passed over into the Balcoracana Creek. This creek, which is the most important waterway in the neighbourhood, takes its rise in The Bunkers, which are a continuation of the Nildottie Ranges that occur on the southern side of Patawarta. There was a strong flow of water in the creek at the time of passing.

On the southern side of the Balcoracana Creek is situated the Grindstone Range, or the "Little Bunkers." These form an isolated range of hills, about 3 miles from Wirrealpa, and are intersected, at one end, by the Balcoracana Creek. They consist of purple sandstones and shales, the latter, wasting more rapidly than the former, produce an outline of peaks and depressions, from which feature they have received the name of "bunkers," on account of their resemblance to the main range of The Bunkers, on their western side The "white cliff," or the "grindstone cliff," in the range, is formed of a sharp fine-grained sandstone, which is used locally for making grindstones, from which the range has received its secondary name: strike S. 20° W., dip easterly at 63°.

Went up stream, in the Balcoracana Creek, to the junction of small creek which comes in from the north-east. The main creek channel, almost immediately, going up stream turns due west and makes a gorge that penetrates the high range (The Bunkers), which has a south-south-easterly direction from the "Big Hill" of Erengunda Creek to the locality under examination.

Having reached the base of the high range, the eastern side of the range was found to form a dip slope of the Archaeocyathinae limestones, from top to bottom, but the fossils are not very well preserved. The dip of the beds, at the bottom of the range, reads E. at 48°. The limestone beds have a rolling curviture along the strike which, at times, causes angles in the outcrops, with slightly varying directions of dip. I was informed by Mr. Napier that the range has a steep slope on its western side and is followed by a high range of hard quartzite rock, similar to that which accompanies the Archaeocyathinae beds at Wirrealpa Hill, at the "Big Hill," on the Erengunda Creek, and elsewhere. These quartzites, with their interbedded shales, form the true "Bunkers."

In a small creek, on the eastern side of the range, there is a thin bed of laminated limestone that is extremely contorted, making acute v-shaped folds, with a dip S.W. at 45°. This bed is similar to the perpendicular and contorted thin limestone met with, in about the same stratigraphical position, at the old Wirrealpa station. A quartzite overlies the limestone (as it does at the old station), then follow rotten purple slates, extending over a distance of half a mile, between the base of the range and the Balcoracana Creek.

At the southern side of the Balcoracana Creek, facing the main range, is a high hill showing a scarp face to the valley. The beds, seen in section, consist of thick, soft, and red-coloured sandstones, interbedded with purple and other coloured, thin-bedded, argillaceous beds, which cross the creek near the east and west bend of the stream.

Resting on the dip-slope of the last-named red sandstones and shales is the bed corresponding to the Five-mile Ridge limestone, which, at a distance of a few yards, is followed by the oolitic and *Obolella* limestone (see Section). At the immediate junction of the north-easterly tributary (mentioned above) with the main creek, a fine and complete section of these limestones occurs in the creeks, with a dip E. 10° N. at 45°. The fossiliferous limestone is sometimes flaggy and nodular in structure. The bed is rich in *Obolella* and other Brachiopods (in some cases the interior of the shells is filled with rhombohedral crystals of calcite), Pteropods, and abundant fragments of Trilobites, but none were seen sufficiently complete to permit of further determination. The fossiliferous zone, so far as a few minutes' examination could determine, was limited to a few inches in thickness.

Overlying the above-mentioned limestones is a thick series of soft, thick-bedded, red sandstones, interbedded with sandy shales, usually red coloured, with dip E. 10° S. at 48°. These beds are intersected by small creeks, which have carved out fair-sized hills on the western side of the main creek.

In superior position to the last-named red sandstone is a limestone, 5 ft. wide, laminated and contorted and interbedded with purple shales, having a dip E. 20° N. at 65°. Then follow, in ascending order, purple and greenish shales with thin bands of limestone, then a series of small ridges showing scarp faces to the north-west, consisting of red sandstones and flags. A high ridge follows before reaching a valley which separates the latter from the Grindstone Range, or Little Bunkers, as described above.

The north-eastern angle of the Grindstone Range was then followed, where the range passes down to soft and decomposing sandy flags and shales, which cross the Balcoracana Creek on that side: dip E. 20° N. at 50°, changing to a dip E.

WILKAWILLINA GORGE.

This gorge occurs in the Mount Billy Creek (or Tenmile Creek), situated about 6 miles to the southward of the Grindstone Range. A remarkable exposure of the Archaeocyathinae limestone occurs at this spot. The limestone is associated with a great range of hills that are about 600 ft. in height: strike N.W. (dip S.E. at 15°). The fossiliferous limestone forms the bed of the creek for about a quarter of a mile in length. Near its upper part the rock is almost one mass of Archaeocyathinae. The matrix, as a whole, is a white crypto-crystalline marble which, throughout the greater thickness of the limestone, only occasionally shows the presence of the fossils; the latter, most likely, having been largely destroyed in the alteration of the rock texture, but near the top the fossils are better preserved. The most striking feature of this outcrop is that the grain of the stone permits its ready fracture, in such a way that the fossil "cups" can be broken out from the matrix so as to show the external form of the organism. This is the only instance that has come under my observation in which this can be done. The matrix in which the Archaeocyathinae are usually included is of an amorphous and refractory character, and is of the same nature within the fossils as in the surrounding matrix, so that the rock fractures uninfluenced by the presence of the organic remains. The only approximate condition for obtaining the objects free from the matrix, naturally, in the normal limestone, is where the organism has undergone silicification, by which the fossil is produced in relief on the weathered surface, as in the case of the Ajax specimens.

The fossiliferous limestone in the Wilkawillina Gorge is overlain by purple shales, and underlain by strong beds of purple sandstone, divided by thinner beds or partings of the same kind.

XVII. LITHOLOGIC FEATURES.

The country dealt with in this paper supplies the most extensive series of the Upper Cambrian beds that has come under my observation. The lithology of the beds agrees very closely with the occurrence of beds of the same age in other parts of South Australia, and include quartzites, sandstones, shales (or slates), limestones, and intrusive igneous rocks.

The *Quartzites* are of two kinds. *(a)* A light-coloured, very fine-grained, and silioeous rock that possesses great resistance to weathering, and forms pointed and serrated outcrops that make prominent features in the landscape. A rock of this kind usually underlies the Archaeocyathinae limestones. *(b)* The other variety is of a dull-red or purple colour, and is usually divided up into layers of a few inches, or a foot or two, in thickness, separated from each other by indurated shales or finely-laminated bands of quartzite. The term "flaggy" has been used in the present paper to describe features of this kind.

Sandstones occur of various colours, mostly red. These are especially characteristic of the eastern side of the ranges. They are, usually, more or less argillaceous in composition, finely-laminated, and cross-bedded, generally soft, and sometimes friable. They have been utilized, to some extent, as flags; but are, generally, too soft for such a purpose.

Shales (or *(?) Slates).*—These form the predominant element in the sedimentary rocks of the district. In some instances they may have developed an incipient cleavage and could be called slates; but, in a general way, they are readily fissile, splitting on the bedding planes, and from intimate jointing break up into cuboidal fragments. As it is not always an easy matter to draw a line of distinction between slates and shales in the field, the term "shale" has been adopted, uniformly, for this class of rock throughout the paper. They sometimes possess a greenish or drab colour, but they are preponderantly of a purplish tint and are, collectively, classed as "purple shales." Like the quartzites and sandstones, they are often divided up into definite layers of a few inches thick and have the features of "flags." Occasionally they make prominent heights, but more commonly they weather rapidly and make low ground.

The *Limestones* are both numerous and of varied types. Magnesia enters largely into the composition of many of them. Some are true dolomites, while many others have a marked dolomitic character. As it is often impossible, in the field, to distinguish a true dolomite from some dolomitic limestones, it was considered better to describe this class of rock, as a whole, as dolomitic limestones. There are bluish limestones, exactly similar in appearance, to the Carboniferous limestones of Europe; siliceous limestones, and arenaceous limestones. Many of the thinner limestones have an oolitic structure, and it sometimes happens that the oolitic grains and rounded sand grains occur together in a rock in about equal quantities. In one instance (in Wilkawillina Gap) an oolitic limestone, at one particular zone, had become altered to an oolitic flint. The *Archaeocyathinae limestones* form a group by themselves. They are, usually, relatively pure, but in places show siliceous and earthy veins and patches, which weather into relief. The same happens when the included fossils have undergone some measure of silicification, when they make most interesting and showy faces on the weathered surface of the rock. Occasionally the limestone partakes of the nature of a marble, either dark coloured or nearly white. A change of texture, of this kind, is generally destructive of the organic remains, which become altered and indistinguishable from the cryptocrystalline matrix. The Archaeocyathinae outcrops in the district appear to be limited to two distant localities, the one on the western side of Blinman and the other on the eastern. In the western outcrops the beds form the foot hills of the Flinders Ranges, facing the western plains, where they extend both north and south of the Parachilna Gorge. In the eastern areas of outcrop they are more irregularly placed. They follow, to some extent, The Bunkers, running in a south-eastern direction, where outcrops were visited at the "Big Hill," at the head of the Balcoracana Creek, and in the Wilkawillina Gorge, measuring from point to point a distance of 16 miles. There is, apparently, another line of strike that passes in a north-easterly direction, diverging from the "Big Hill," passing by the old Wirrealpa station; a small faulted patch occurs near Mount Lyall; and then, following in the same direction (after a distance of about 20 miles), there is another important outcrop of the limestone in the Mount Chambers Creek.

The *Igneous Rocks* are restricted, so far as the present observations are concerned, to two localities; one of these is in the neighbourhood of Blinman (especially developed on the western side of the township), and the other occurs on the eastern side of the "Big Hill," nearer to Wirrealpa. The occurrence of intrusive pipes, of a circular outline, are interesting features as indicating ancient volcanic vents that have been cut back by denudation. Petrographically, the rocks belong, mostly, to the diabase types (see Benson, "Basic Rocks of Blinman," Roy. Soc. S Austr., xxxiii., 1909). The amount of alteration induced in the adjacent rocks by contact metamorphism varies considerably with the different dykes. In some cases, little or no alteration can be detected, while in others some quartz and allied minerals appear to owe their development to contact with the dyke. Siderite, hematite, limonite, and copper ores are frequently found in dolomitic limestones near the junction of these beds with an igneous dyke. It is an interesting fact that on the south-eastern spurs of Mount Remarkable a small field of igneous dykes occur, having similar petrographical features to those found near Blinman, and which intrude rocks of a similar geologic age (see Thiele, Roy Soc. S. Austr., xl., 1916, p. 580).

The association of igneous dykes, dolomitic limestones, and copper ores is a characteristic feature of the Blinman mining field. Dr. Lander's mine, which I visited, situated near to Blinman, about a quarter of a mile to the southward of the old Blinman to Parachilna road, is typical of most of these mines. The ore occurs in bunches, immediately below an igneous dyke, which is intrusive at a low angle. The carbonates and oxides of copper, siderite, and hematite, together with some quartz, are distributed through a metalliferous zone, mixed with vein stuff, up to 9 ft. in diameter. Below the ore zone is a broken-down shale, containing a little ore, and this latter rests on dolomitic limestone.

The *Scenic Aspects* of the Flinders Ranges are often very striking, and certainly unique in South Australian scenery. Under arid conditions, the weathering agencies have sculptured the country into sharp and rugged outlines, producing bare hills and mural cliffs. The prevailing red colour of the rocks also gives an unusual tone to the landscapes and lends itself to uncommon colour effects. When standing on some vantage point, commanding a view of the surrounding hills, especially with the slanting rays of the setting sun thrown upon the scene, the picture is full of a weird beauty. The bare scarps of the ranges look like enclosing walls, the red rocks possess a higher colour by reflecting the lurid sunset, and the glow on the rising mists of the valleys all combine to give the appearance of a vast furnace or the floor of a smoking volcano.

XVIII. TECTONIC PHENOMENA.

The main geological structures of the region under description are relatively simple. The great fault-scarp, facing west, by which the Flinders Ranges are suddenly cut off in that direction and are replaced by the flat and sandy shores of Lake Torrens, makes a very sharp boundary line, both topographically and geologically.

At the entrance to the gorge the Archaeocyathinae limestones are at a lower level and considerably lower angle of dip than the great scarp quartzite on which they rest. This stratigraphical discordance may possibly represent an angular unconformity in the geological succession, separating two series of beds that are of different ages. Its evidence in this direction is rendered doubtful, however, in that the displacement (if such exists) occurs on the nearly vertical face of the escarpment which forms the eastern wall of the great South Australian rift valley. This line of major faulting is accompanied by many secondary fractures and block faulting, the respective "blocks" settling down at various angles. It was a matter of regret that the necessary time could not be spared for making such detailed observations as might have settled this interesting question.

The tectonics of the ranges are fundamentally based on periclinic and cycloclinic foldings, together with much lateral movement. The long curves of the folds can be noted from the train, going north, from Mernmerna Station (fig. 3). At the latter position, the western scarps of the Elder Range make a bold feature; and a little further north, the western wall of the Wilpena Pound Range is equally impressive. A rough sketch of these mountains in section is given here.

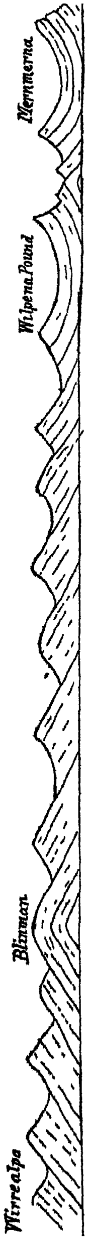

Fig. 3.

A Diagrammatic Sketch-section from Mernmerna to Blinman, 40 miles.

Blinman occupies the centre of a great earth movement of elevation. The tangential forces have acted from all sides, almost equally, with the effect that the whole district, from Parachilna Gorge to Wirrealpa Old Station, in a diameter of 20 miles, has been raised in the form of a vast dome. The upper beds form the outer rims of the dome, and the centre, much reduced by denudation, exposes the lower members of the series. According to official figures, Blinman has a height of 2,020 ft. above sea level. Parachilna railway station, on the plain, is 465 ft. above the sea level, and the great escarpment at the Parachilna Gorge is probably 1,000 ft. higher than the railway.

The quaquaversal dip of the beds around the apical portion of the dome is fairly consistent as to direction, but varies much in the angle of dip. The Archaeocyathinae limestones represent the highest exposed horizon on the western side, the beds in superior position having been thrown down by the great north and south fault, and have become obscured by recent alluvia and blown sand. From the gorge on the west to Blinman, a distance of about 10 miles, the prevailing dip is westerly. From Blinman to the Archaeocyathinae beds at the old Wirrealpa station, on the east, at a similar distance of about 10 miles, the prevailing dip is easterly. At about the same distance to the northward of Blinman is Patawarta Hill, which probably represents the thick quartzites that underlie the Archaeocyathinae limestones at the Parachilna Gorge, and, if so, those fossiliferous limestones might be expected to occur on its northern slopes.

A 10-mile section of rocks that lie in one direction, at a fairly high angle of dip, would make a very thick series, and suggests the possibility of faulting along the strike that might cause a repetition of the beds and give a fictitious appearance as to their thickness. Minor faults were recognized in several places, but nothing came under my observation that looked like a repetition of the beds on a large scale, although in a single traverse such an occurrence might easily be overlooked.

One of the features of the district is the great amount of crush-rock that is developed, at intervals, over scores of square miles. This class of rock takes all the forms usually developed under such conditions, *viz.*, crush-breccia, crush-conglomerate, over-riding, and sometimes telescoping, when the shales and dolomites interpenetrate one another. Some of the purple shales are, in places, crushed into a confused mass in which signs of bedding can only be recognized in disconnected fragments. These features are, perhaps, in greatest evidence where the igneous rocks are in close proximity. The only locality where I have noticed autoclastic phenomena in any degree comparable to this is along the flanks of the great horst that forms Mount Remarkable (see Howchin, "Geology of Mount Remarkable," Roy. Soc. S. Austr., xl., 1916, p. 545) In the latter case the crush-rock has been caused by vertical faulting on a large scale; in the northern Flinders Ranges, lateral faulting, by a sliding horizontal motion, has been of common occurrence, and would, probably, be more potential in causing "crush" than vertical movements.

The beds above the horizon of the Archaeocyathinae limestone, which outcrop near the Wirrealpa Station and in the upper part of the Balcoracana Creek, are the highest members of the Upper Cambrian Division that have been hitherto recorded in South Australia. With the exception of a thin bed of laminated and contorted limestone that occurs a little higher in the series than the Archaeocyathinae horizon, these top beds are not much disturbed. They consist, mostly, of softish and highly-coloured sandstones and shales with one highly fossiliferous horizon (the *Obolella* limestone), which is of no great thickness.

As to the physical conditions under which the beds were laid down, the evidence seems to point to shallow water, if not dry land conditions, at some horizons. Some of the limestones have a nodular, or subglobular, kind of structure, which is seen on the weathered surface, and when split by the hammer break up into more or less rounded fragments, which have a close likeness to the surface concretionary travertines that form in calcareous soils under an arid climate. A specimen picked up near the old Wirrealpa station showed what had been, in the first instance, projecting cups of Archaeocyathinae, and then were contemporaneously surrounded by concretionary limestone, such as might have been formed following on the elevation of a reef of these organisms above the level of the sea. The very common occurrence of oolitic limestones, and oolitic sandstones in which the oolitic grains and rounded sand grains are mixed up together (very much as they occur in present-day deposits laid down in a shallow lake, near Robe, which is alternately wet and dry) (see Howchin's "Geology of South Australia," p. 176, figs. 152-154). Still further, the red and friable sandstones, much cross-bedded, near the top of the series have features that favour the idea of a terrestrial origin.

DESCRIPTION OF PLATE IV.

Fig. 1. Geological sketch-section of outcrops from the mouth of the Parachilna Gorge to the vicinity of Blinman.

Fig. 2. Geological sketch-section from Blinman to the northern side of the Erengunda Creek.

Fig. 3. Geological sketch-section from The Bunkers to the Eastern Plains.

Note.—The Geological Sections, as described above, are made as detailed as the nature of the outcrops permitted. The rapid changes, in succession, of quartzites, shales, and limestones, within short distances, render it impossible to note such occurrences, in detail, within the limits of the scale adopted. The dip of the beds, also, varies greatly, in places, within short distances. It must therefore be taken for granted that the sections are, to a large extent, generalized rather than exact. A further difficulty arose from the quaquaversal curves in the dip, so that in some parts of the section the line follows a true direction of dip, while, in others, it approximates to the line of strike, in which case important beds, situated on one, or other, of the sides of the section, and running parallel with it, could not be shown in section.

TWO NEW SPECIES OF LYCOSA FROM SOUTH AUSTRALIA.

By R. H. Pulleine, M.B., C M.

[Read November 10, 1921.]

Plate V.

Up to the present seventy species of *Lycosa* have been described as Australian. This is probably only a fraction ot the whole of this immense genus existing on our continent. Owing to the great powers of locomotion of the young *Lycosa* it is not safe to view every Australian species as endemic without further investigation. Some eremeian species also show variations in colour of almost specific value; but connecting variations can be found which even invalidate their varietal value. The two species described are certainly new, and the types are preserved in formalin in the collection of the South Australian Museum.

I have found that the species of *Lycosa* described by H. R. Hogg (P.Z.S. Lond., 1905, vol. ii., p. 569), and preserved in the South Australian Museum collection, are, from long immersion in alcohol, in poor condition for identification.

Lycosa skeeti, n. sp.

♀. Cephalo-thorax light brown, clothed with silvery-grey hair; a darker brown median streak with four similar streaks on each side.

Mandibles concolorous, clothed with long silvery hair. Lip maxillae and sternum dark brown.

Abdomen light brown above, dark brownish-black below, spinnerets of the same colour, lighter in shade.

Legs and palpi the same colour as the thorax. They are clothed with fine silvery hairs interspersed with strong black spines.

The eye area is prominent, and the arrangement of the eyes, which are black and shining, is of the ordinary *Lycosa* type. In the eye area and on the clypeus are strong, erect, yellowish-brown hairs.

The markings of the dorsum of the abdomen are as follow:—Posteriorly, two nearly straight black parallel lines meeting at their ends; anteriorly to this, three parallel sinuate lines; in front, two lateral black, forked lines, not meeting medially.

Epigyne small, shining brown of simple form, *viz.*, two depressions with a median ridge.

Total length, 65 mm.; thorax abd., 25 mm.

This striking species of *Lycosa* was sent from Wilson, Flinders Range.

Type in South Australian Museum. Male unknown.

Named after Mr. H. C. Skeet, of Melbourne, an enthusiastic collector for other naturalists.

LYCOSA PERINFLATA, n. sp.

Cephalo-thorax broad, compressed, nearly circular in outline; warm reddish-brown, covered with fine white adpressed hairs.

Median brown lines extending on to eye area in front, uniting behind and then spreading into a broad fork with radiating brown lines and spots on either side, running into a brown splashed area on the margins of the thorax.

Maxillae dark shining brown with thick tomentum of fine white hairs interspersed with darker brown ones.

Lip and maxillae reddish-brown, sternum and coxae darker with fine clothing of black hairs.

Abdomen above, dirty white with four discrete broad greyish-black bands interspersed with small spots and a similar densely-spotted area at sides of abdomen.

Below, yellowish-white with a broad central black band narrowing towards spinnerets, which are likewise black.

The whole abdomen is clothed with a fine white tomentum.

The eye area, of usual shape, appears white from the thickness of the tomentum.

Legs dark brown, under-surface of tibiae densely clothed with white hairs, showing marked contrast with the remaining joints.

Total length, 73 mm.; thorax abd., 27 mm.

This robust *Lycosa* was found at Whyte-Yarcowie, South Australia.

Type in South Australian Museum. Male unknown.

DESCRIPTION OF PLATE V.

Lycosa skeeti, n. sp.
Nat. size.

Lycosa perinflata, n. sp.
Nat. size.

THE PARASITES OF AUSTRALIAN BIRDS.

By J. BURTON CLELAND, M.D.

[Read May 11, 1922.]

Apart from the interest centred in themselves zoologically as species and genera of animals, the parasites of birds may claim special attention from ornithologists on several grounds connected with their hosts. It is with the bird aspect that this contribution deals.

The ecto- and endo-parasites of birds may affect their health. In a state of Nature we have little evidence of this as far as our native species are concerned. Attention may be called, however, to the helminth ova found in tumours in the intestine of a black duck.

In certain cases, ornithologists may perhaps gain considerable help from a study of bird parasites in establishing generic affinities in otherwise doubtful cases With some exceptions, and excluding occasional accidental infections of birds of other genera, both such external parasites as mallophaga and such internal ones as the helminths are probably remarkably specific as regards their hosts: that is, are confined to one species of bird only or to a few closely-allied species. In a broader sense, this may also apply to genera. The reason for this specification is clear. The ancestors of the parasites undoubtedly began their parasitic career as accidental infestations, individuals gaining access to their hosts in some way, being able to resist the efforts of these hosts to dislodge them, and being capable of nourishing and reproducing themselves in their new environment. In the course of time they became structurally more and more modified to fit themselves for the parasitic life. Modifications suitable for one host might be unsuitable for others. Passage would more easily be achieved from one host to another of the same species. During the period in which the parasites were undergoing these marked evolutionary changes, their hosts would also be doing the same. Sometimes the parasites would change structurally more quickly or more markedly than their hosts, and then we would have perhaps two or more closely-allied species of parasite in one specific host or in two or in several closely-related hosts In other cases the parasites might remain more or less stationary, whilst considerable structural changes might occur in several directions in the descendants of the original host.

We then might have identical or closely-allied parasites in two or more related species or in closely connected genera. A generic or even family relationship might thus be shown, and it is possible that a disputed point might be settled in this way. Thus, supposing a genus X appears to be related either to the genus Y or to the genus Z, if X and Y have closely related parasites and those of Z are distantly connected, then support is found for the relationship with Y rather than Z.

L. Harrison (Parasit., viii., 1915, pp. 88-100), in an article on "Mallophaga from *Apteryx*, and their significance, with a note on the Genus *Rallicola*." deals in an interesting way with the value of these ecto-parasites as showing probable affinities amongst their hosts.

The following extract from Nature (No. 2330, vol. 93, June 25, 1914, p. 439) shows another interesting phase of this subject:—"From a paper by Mr. H. Victor Jones in the February number of the Zoologist on certain parasites of birds, we learn that while rooks and the diurnal birds-of-prey—probably owing to the strength of their gastric juices—are practically free from intestinal infestations of this kind, curlews show, on the average, no fewer than 49·5 per head. As there seems to be a connection in many species between the numbers of external and internal parasites, it is suggested that some of the former may serve as hosts for the latter during the earlier stages of their development."

There is clearly very much work still to be done in the parasitology of Australian birds. I have now collected a considerable number of mallophaga and worms which await description when our few investigators in these subjects have time to consider them. Cestodes have already been described from 44 species of our birds. I record their occurrence in 59 species, of which 50 are new hosts. Cestodes, it will be seen from the attached list, are rare in our wild parrots, have not yet been met with in our cuckoos, are common in the honey-eaters, and occur in several of the Ptilonorhynchidæ, as well as in other genera. I have not found any in the Acanthizas (9 species and 30 individuals) or in *Sericornis* (4 species and 15 individuals). Here it may be mentioned that, once helminth parasites are "dropped" by a host-species or host-genus, with rare exceptions it is very unlikely that such species or genus will ever again become infested by such parasites. In other words, these parasites are usually so highly specialized that they can only exceptionally adapt themselves to hosts of a quite different kind, and new true parasites derived from semi-parasites only very rarely arise.

The following summarises the results of previous records and my findings in birds examined:—

Cestodes recorded previously in 45 species. Found by me in 59, of which 50 are new hosts.
Adult nematodes recorded previously in 21 species. Found by me in 22, of which 15 are new hosts.
Microfilariae recorded previously in 34 species.
Acanthocephala recorded previously in 21 species. Found by me in 10, of which 6 are new hosts.
Trematodes recorded previously in 38 species. Found by me in 1.
Fleas recorded previously in 1 species. Found by me in 2, of which 1 is a new host.
Hippoboscidae recorded previously in 3 species. Found by me in 1, which is a new host.
Mallophaga recorded previously in 64 species. Found by me in 65, of which 54 are new hosts.
Ticks recorded previously in 1 species. Found by me in 4, of which 3 are new hosts.
Mites recorded previously in 18 species. Found by me in 22, of which 21 are new hosts.
Haemosporidia recorded previously in 47 species.
Haemoflagellates recorded previously in 12 species.

In 302 individuals, comprising 132 species, no entozoa were detected. Though it is probable that, in some of these, parasites were overlooked (and in some of the species they have been previously recorded), the number of infested birds thus missed is probably small. No ectozoa were detected on 61 individuals belonging to 46 species.

The numbers following the names of the birds are those of the check-list published in the Emu, vol. xii., 1912-3.

PT. I.—RECORDED PARASITES OF AUSTRALIAN BIRDS.

1. Cestodes.(1)

Order CASUARIIFORMES.

Dromaius novae-hollandiae (No. 1).—Davainea australis, *Krabbe;* Cotugnia collini, *Fuhr.*

Casuarius australis (No. 4.)—Cestodes in intestine, N.Q., *Macgillivray* (Emu, xvii., 1917, p. 80).

Order COLUMBIFORMES.

Leucosarcia picata (No. 40).—Davainea sp., *Johnst.*

Order PODICIPEDIFORMES.

Podiceps gularis (No. 57).—Taenia novae-hollandiae, *Krefft;* Taenia paradoxa, *Krefft.*

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(1) Unless a full reference is given, the references to the various records will be found in a paper by Dr. T. Harvey Johnston on "Internal Parasites recorded from Australian Birds" (Emu, vol. xii., 1912, p. 105), which forms the basis for this List.

Order PROCELLARIIFORMES.

Diomedea exulans (No. 94).—Tetrabothrius sp., *Jnstn.*

Diomedea melanophrys (No. 95).—Tetrabothrius sp., *Jnstn.*

Order CHARADRIIFORMES.

Lobivanellus lobatus (No. 128).—Gyrocoelia sp., *Jnstn.* (Ann. Trop. Med. and Paras., viii., 1914, p. 108).

Zonifer pectoralis (No. 130).—Choanotaenia zoniferae, *Jnstn.*

Himantopus leucocephalus (No. 142).—Gryocoelia australiensis, *Jnstn.* (Taenia coronata, *Krefft*); Acoleus hedleyi, *Jnstn.* (Taenia rugosa, *Krefft*); Davainea himantopodis, *Jnstn.*; Hymenolepis sp., *Jnstn.*

Gallinago australis (No. 166).—Aploparaksis australis, *Jnstn.*

Oedicnemus grallarius (No. 171).—Angularia australis, *Maplestone* (Ann. Trop. Med. and Parasit., xv., No. 4, 1921).

Order ARDEIFORMES.

Platalea regia (No. 178).—Cylorchida omalancristrota, *Wedl.*

Platibis flavipes (No. 179).—Hymenolepis ibidis, *Jnstn.*

Xenorhynchus asiaticus (No. 180).—Clelandia parva, *Jnstn.*

Herodias syrmatophorus (timoriensis) (No. 184).—Anomotaenia asymmetrica, *Jnstn.*; Bancroftiella glandularis, *Fuhrm.*

Notophoyx novae-hollandiae (No. 185).—Bancroftiella glandularis, *Fuhrm.*

Nycticorax caledonicus (No. 191).—Bancroftiella ardeae, *Jnstn.*; Hymenolepis sp., *Jnstn.*

Order ANSERIFORMES.

Anseranas melanoleuca (No. 199).—Hymenolepis megalops, *Nitzsch*; Hymenolepis terraereginae, *Jnstn.*

Dendrocygna arcuata (No. 204).—Diploposthe laevis, *Bl.*; Diorchis flavescens *(Krefft)*, Maplestone (Ann. Trop. Med. and Parasit., xv., No. 4, 1921, p. 403).

Anas superciliosa (No. 208).—Hymenolepis megalops, *Nitzsch* (Taenia cylindrica, *Krefft*); H. collaris, *Batsch.* (Taenia bairdii, *Krefft*); Hymenolepis sp., *Jnstn.*; Diorchis flavescens, *(Krefft)*; Fimbriaria fasciolaris, *Pall.* (Taenia pediformis, *(Krefft)*; Diploposthe laevis, *Bl.*

Nettium castaneum (No. 209).—Diorchis flavescens *(Krefft)*; Diploposthe laevis, *Bl.*; Hymenolepis collaris, *Bat.*; Hymenolepis megalops, *Nitzsch* (Taenia cylindrica, *Krefft*); Fimbriaria fasciolaris, *Pall.*

Spatula rhynchotis (No. 213).—Diorchis flavescens *(Krefft)*.

Nyroca australis (No. 216).—Diploposthe laevis, *Bloch* (Taenia tuberculata, *Krefft*); Diorchis flavescens *(Krefft)*.

Biziura lobata (No. 218).—Taenia moschata, *Krefft.*

Order PELECANIFORMES.

Tachypetes (Fregata) aquila (No. 229).—Tetrabothrius sp., *Jnstn.*

Order ACCIPITRIFORMES.

Accipiter torquatus (No. 240).—Anomotaenia accipitris, *Jnstn.*

Order PSITTACIFORMES.

Trichoglossus swainsoni (No. 274).—Moniezia trichoglossi, *Linstow.*

Cacatua galerita (No. 291).—Davainea cacatuina, *Jnstn.*

Platycercus eximius (No. 311).—Dilepis bancrofti, *Jnstn.*

Order CORACIIFORMES.

Dacelo gigas (No. 345).—Similuncinus dacelonis, *Jnstn.*

Order PASSERIFORMES.

Petroica goodenovii (No. 394).—Hymenolepis sp., *Jnstn.*
Pachycephala rufiventris (No. 430).—Sphaeruterina punctata, *Jnstn.* (Proc. Roy. Soc. Q'land, xxvi., 1914, p. 76).
Malurus cyaneus (No. 530).—Choanotaenia taylori, *Jnstn.*
Zosterops dorsalis (No. 599).—Zosteropicola clelandi, *Jnstn.*
Conopophila albogularis (No. 634).—Davainea conopophilae, *Jnstn.*
Ptilotis chrysotis (No. 644).—Choanotaenia meliphagidarum, *Jnstn.*
Ptilotis leucotis (No. 651).—Choanotaenia meliphagidarum, *Jnstn.*
Meliornis novae-hollandiae (No. 668).—Choanotaenia meliphagidarum, *Jnstn.*
Meliornis sericea (No. 669).—Choanotaenia meliphagidarum, *Jnstn.*
Entomyza cyanotis (No. 680).—Davainea conopophilae, *Jnstn.*
Philemon citreogularis (No. 685).—Davainea conopophilae, *Jnstn.*
Sphecotheres maxillaris (No. 714).—Davainea sphecotheridis, *Jnstn.* (Ann. Trop. Med. and Parasit., viii., 1914, p. 106).
Chlamydera maculata (No. 722).—Choanotaenia chlamyderae, *(Krefft).*
Ptiloris alberti No. 730).—Biuterina clavulus, *Linst.*
Corvus coronoides (No. 732).—Davainea sp., *Jnstn.*

2. **Nematodes** (omitting Microfilariae).(2)

Order GALLIFORMES.

Catheturus lathami (No. 7).—Heterakis bancrofti, *Jnstn.*; Heterakis catheturinus, *Jnstn.*

Order PROCELLARIIFORMES.

Daption capensis (No. 86).—Rictularia shipleyi, *Stoss* (probably).

Order ANSERIFORMES.

Chlamydochen jubata (No. 203).—Heterakis chenonettae, *Jnstn.*

Order PELECANIFORMES.

Phalacrocorax carbo (No. 219).—Ascaris sp., *Jnstn.*
Phalacrocorax sulcirostris (No. 220).—Ascaris spiculigera, *Rud.*
Plotus novae-hollandiae (No. 224).—Ascaris spiculigera, *Rud.* (Ascaris sp., *Krefft).*
Pelecanus conspicillatus (No. 233).—Ascaris spiculigera, *Rud.(?)*

Order ACCIPITRIFORMES.

Falco lunulatus (No. 258).—Filaria sp., *Jnstn.*
Hieracidia berigora (No. 259).—Filaria guttata, *Schneider.*

Order STRIGIFORMES.

Ninox boobook (No. 263).—Filaria sp., *Jnstn.*
Ninox ocellata (No. 264).—Filaria sp., *Jnstn.*

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(2) For references, *vide* footnote to List of Recorded Cestodes of Australian birds.

Order CORACIIFORMES

Sub-order PODARGI.

Podargus sp.—Nematodes, *Bancroft* (Proc. Roy. Soc. Q'land, 1889, p. 60).

Sub-order HALCYONES.

Dacelo leachi (No. 346).—(Filaria) dacelonis, *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 42).

Order PASSERIFORMES.

Fam. CAMPOPHAGIDAE.

Graucalus melanops (No. 457).—Filaria sp., *Jnstn.*

Fam. MELIPHAGIDAE.

Myzantha garrula (No. 672).—Filaria sp., *Bancroft.*

Anthochaera carunculata (No. 675).—Oxyspirura anthochaerae, *Jnstn.* (Proc. Roy. Soc. Q'land, xxiv., 1912, p. 80) (Ceratospira anthochaerae, *Jnstn.*; Ascaris sp., *Krefft*).

Annellobia mellivora (No. 677) (recorded as A. lunulata).- Filaria sp., *Bancroft.*

Acanthogenys rufigularis (No 679).—Filaria sp., *Jnstn.*

Philemon citreogularis (No. 685).—Filaria sp., *Jnstn.*

Fam. CORVIDAE.

Corvus australis (No. 734).—Filaria sp., *Bancroft.*

Fam. STREPERIDAE.

Cracticus destructor (No. 745).—Filaria sp., *Bancroft.*

Gymnorhina tibicen (No 747).—Filaria clelandi, *Jnstn.*

2a. Microfilariae.(3)

Microfilariae have been described or merely recorded from the following species of Australian birds:—

Order PELECANIFORMES.

Phalacrocorax sulcirostris (No. 220); P. melanoleucus (No. 223); Plotus novae-hollandiae (No. 224).

Order ACCIPITRIFORMES.

Accipiter torquatus (No. 240).

Order PSITTACIFORMES.

Trichoglossus swainsoni (No. 274), *Bancroft* (Proc. Roy. Soc. Q'land, vi., 1889 [1890]); Glossopsitta pusilla (No. 280).

Order CORACIIFORMES.

Podargus strigoides (No. 337); Eurystomus pacificus (No. 341).

Order PASSERIFORMES.

Fam. PITTIDAE.

Pitta strepitans (No. 377), *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 43).

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(3) For references, *vide* footnote to List of Recorded Cestodes of Australian Birds.

Fam. Muscicapidae.

Myiagra plumbea (No. 444).

Fam. Timeliidae.

Psophodes crepitans (No. 476); Pomatorhinus temporalis (No. 478) (Pomatostomus frivolus).

Fam. Turdidae.

Oreocincla lunulata (No. 488).

Fam. Artamidae.

Artamus leucogaster (No. 559); A. sordidus (No. 564) (Artamus tenebrosus).

Fam. Prionopidae.

Colluricincla harmonica (No. 566), *Cleland* (these Trans., xxxix., 1915, p. 33).

Fam. (?)

Struthidea cinerea (No. 576); Corcorax melanorhampus (No. 577).

Fam. Dicaeidae.

Pardalotus melanocephalus (No. 609), *Cleland* and *Jnstn.* (Jour. Proc. Roy. Soc. N.S. Wales, xlv., 1911, p. 433).

Fam. Meliphagidae.

Plectorhyncha lanceolata (No. 621); Myzomela sanguineolenta (No. 622); Stigmatops ocularis (No. 639); Ptilotis fusca (No. 643); Myzantha garrula (No. 672); Anellobia mellivora (lunulata of *Bancroft's* record) (No. 677); Entomyza cyanotis (No. [illegible]); Philemon citreogularis (No. 685).

Fam. Oriolidae.

Oriolus viridis (No. 712).

Fam. Dicruridæ.

Chibia bracteata (No. 716).

Fam. Ptilonorhyncidae.

Sericulus chrysocephalus (No. 726).

Fam. Corvidae.

Corvus coronoides, Corvus australis (Nos. 732, 734).

Fam. Streperidae.

Strepera graculina (No. 735), *Bancroft* (Proc. Roy. Soc. Q'land, vi., 1889 [1890]; Cracticus nigrogularis (No. 741); C. destructor (No. 745).

Gymnorhina tibicen (No. 747).—Microfilaria gymnorhinae, *Gilruth, Sweet*, and *Dodd*.

3. Acanthocephala.(4)

Order GALLIFORMES.

Catheturus lathami (No. 7).—Echinorhynchus sp., *Jnstn.*

Order CHARADRIIFORMES.

Numenius cyanopus (No. 145).—Echinorhynchus sp., *Jnstn.*

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(4) For references, *vide* footnote to List of Recorded Cestodes of Australian Birds.

Order ACCIPITRIFORMES.

Astur cinereus (No. 236).—Centrorhynchus asturinus, *Jnstn.* (Proc. Roy. Soc. Q'land, xxx., 1918, p. 216).
Astur novae-hollandiae (No. 237).—Centrorhynchus asturinus, *Jnstn. (loc. cit.).*
Astur approximans (No. 238) (A. fasciatus).—Echinorhynchus sp., *Jnstn.*
Baza subcristata (No. 254).—C. asturinus, *Jnstn. (loc. cit.).*

Order STRIGIFORMES.

Ninox boobook (No. 263).—Echinorhynchus=Centrorhynchus sp., *Jnstn.*

Order CORACIIFORMES.

Podargus strigoides (No. 337).—E. sp., *Jnstn.*
Halcyon sanctus (No. 349).—E. sp., *Jnstn.*

Order MENURIFORMES.

Menura superba (No. 374).—E. menurae, *Jnstn.*

Order PASSERIFORMES.

Fam. MUSCICAPIDAE.

Pachycephala gilberti (No. 432).—Echinorhynchus pomatostomi, *Jnstn.* and *Clel.* (larvae, subcutaneous).

Fam. TIMELIIDAE.

Hylacola pyrrhopygia (No. 474).—E. pomatostomi, *Jnstn.* and *Clel.* (larvae, subcutaneous).
Psophodes crepitans (No. 476).—E. sp., *Jnstn.*
Pomatorhinus temporalis (No. 478).—E. pomatostomi, as above.
Pomatorhinus superciliosus (No. 479).—E. pomatostomi, as above.
Pomatorhinus rubeculus (No. 481).—E. pomatostomi, as above.

Fam. TURDIDAE.

Oreocincla lunulata (No. 488).—Echinorhynchus sp., *Jnstn.*

Fam. PRIONOPIDAE.

Grallina picata (No. 575).—E. sp., *Jnstn.*

Fam. PARIDAE.

Aphelocephala leucopsis (No. 578).—E. pomatostomi, as above.

Fam. CERTHIIDAE.

Climacteris melanura (No. 589) (C. wellsi).—E. pomatostomi, as above.

Fam. MELIPHAGIDAE.

Meliornis novae-hollandiae (No. 668).—E. sp., *Jnstn.*

4. Trematodes.(5)

Order COLUMBIFORMES.

Leucosarcia picata (No. 40).—Harmostomum pulchellum, *S. J. Johnston* (N.S. Wales).

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(5) Compiled from S. J. Johnston's article "On the Trematodes of Australian Birds" in Jour. Proc. Roy. Soc. of N.S. Wales, l., 1916, p. 187.

Order RALLIFORMES.

Porphyrio melanonotus (No. 55).—Echinostomum hilliferum, *Nicoll.*

Order LARIFORMES.

Sterna cristata (No. 107) (S. bergii).—Lyperosomum megastomum, *S. J. Johnston* (N.S. Wales); Holostomum musculosum, *S. J. Johnston* (N.S. Wales).
Larus novae-hollandiae (No. 119).—Austrobilharzia terrigalensis, *S. J. Johnston* (N.S. Wales); Holostomum hillii, *S. J. Johnston* (N.S. Wales).

Order CHARADRIIFORMES.

Lobivanellus lobatus (No. 128).—Haematotrephus consimilis, *Nicoll;* Echinostomum ignavum, *Nicoll.*
Charadrius fulvus (No. 132) (C. dominicus).—Acanthoparyphium spinulosum, *S. J. Johnston* (N.S. Wales); Levinseniella howensis, *S. J. Johnston* (Lord Howe Island).
Himantopus leucocephalus (No. 142).—Haematotrephus adelphus, *S. J. Johnston* (S. Austr.).
Numenius cyanopus (No. 145).—Himasthla harrisoni, *S. J. Johnston* (Q'land).
Limosa novae-hollandiae.—Cyclocoelum taxorchis, *S. J. Johnston* (Lord Howe Island).
Œdicnemus grallarius (No. 171) (Burhinus grallarius).—Platynotrema biliosum, *Nicoll;* P. jecoris, *Nicoll.*

Order GRUIFORMES.

Antigone australasiana (No. 174).—Allopyge antigones, *S. J. Johnston;* Echinostomum australasianum, *Nicoll.*

Order ARDEIFORMES.

Ibis molucca (No. 175).—Patagifer acuminatus, *S. J. Johnston* (Q'land).
Carphibis spinicollis (No. 176).—Echinostoma acuticauda, *Nicoll* (Q'land).
Platalea regia (No. 178).—Orchipedum sufflavum, *Nicoll;* Patagifer bilobus, *Rud.*
Plegadis falcinellus (No. 177).—Patagifer bilobus, *Rud.*
Xenorhynchus asiaticus (No. 180).—Chaunocephalus ferox, *Rud.*
Herodrias (Syrmatophorus) timoriensis (No. 184).—Patagifer fraternus, *S. J. Johnston* (Q'land); Echinoparyphium oxyurum, *S. J. Johnston* (Q'land).
Notophoyx novae-hollandiae (No. 185) (Ardea novae-hollandiae).—Holostomum simplex, *S. J. Johnston;* H. repens, *Chase* (Proc. Linn. Soc. N.S. Wales, xlv., 1921, p. 500) (N.S. Wales).
Nycticorax caledonicus (No. 191).—Clinostomum hornum, *Nicoll.*

Order ANSERIFORMES.

Chenopis atrata (No. 198).—Hemistomum intermedium, *S. J. Johnston;* Hyptiasmus magnus, *S. J. Johnston* (Vict.); Notocotylus attenuatus, *Rud.*
Anseranas melanoleuca (No. 199) (A. semipalmata).—Typhlocoelum reticulare, *S. J. Johnston.*
Nettapus pulchellus (No. 200).—Notocotylus attenuatus, *Rud.*
Anas superciliosa (No. 208).—Echinostomum revolutum, *Froel.;* Notocotylus attenuatus, *Rud.*

Order PELECANIFORMES.

Phalacrocorax melanoleucus (No. 223).—Dolichosaccus solecarius, *S. J. Johnston* (N.S. Wales); Echinochasmus tenuicollis, *S. J. Johnston* (N.S. Wales).

Plotus novae-hollandiae (No. 224).—Clinostomum australiense, *S. J. Johnston* (Q'land).

Order ACCIPITRIFORMES.

Haliaetus leucogaster (No. 246).—Scaphanocephalus australis, *S. J. Johnston.*

Hieracidea berigora (No. 259).—Opisthorchis obsequens, *Nicoll* (Q'land).

H. orientalis (No. 260).—Echinochasmus prothovitellatus, *Nicoll* (Q'land).

Order STRIGIFORMES.

Ninox boobook (No. 263).—Lyperosomum harrisoni, *S. J. Johnston* (N.S. Wales); Strigea promiscua, *Nicoll* (Q'land).

N. maculata (No. 265).—Strigea promiscua, *Nicoll* (Q'land); Hemistomum brachyurum, *Nicoll* (Q'land); H. triangulare, *S. J. Johnston* (N.S. Wales).

Order CORACIIFORMES.

Podargus strigoides (No. 337).—Echinostomum elongatum, *Nicoll.*

Dacelo gigas (No. 345).—Hemistomum triangulare, *S. J. Johnston* (N.S. Wales); Strigea flosculus, *Nicoll.*

Order COCCYGES.

Centropus phasianus (No. 373).—Echinostomum emollitum. *Nicoll.*

Order PASSERIFORMES.

Petrochelidon ariel (No. 387).—Plagiorchis clelandi, *S. J. Johnston* (N.S. Wales).

Microeca fascinans (No. 388).—Echinoparyphium harveyanum, *S. J. Johnston* (Q'land).

Anthus australis (No. 687).—Plagiorchis spatulatus, *S. J. Johnston* (Q'land).

Chibia bracteata (No. 716).—Plagiorchis (Lepoderma) nisbettii, *Nicoll;* Prosthogonimus vitellatus, *Nicoll.*

Strepera arguta (No. 736) (S. versicolor).—Lyperosomum parvum, *S. J. Johnston* (N.S. Wales).

5. Siphonaptera (Fleas).

Order SPHENISCIFORMES.

Eudyptula minor (No. 62).—Parapsyllus australiacus, *Roths.* (Nov. Zool., xvi., 1909, p. 62) (P. longicornis, *Jord.* and *Roths.* [*nec.* Enderl., *err. determ.*]).

6. Diptera.

Order ACCIPITRIFORMES.

White Hawk.—Ornithoctona nigricans, *Leach* (S. Q'land) (*vide* W. W. Froggatt in "Australian Insects").

Order STRIGIFORMES.

Ninox boobook (No. 263).—Ornithomyia perfuga, *Spaĵer,* on an owl, probably this species, near Brisbane (*vide* Froggatt, *loc. cit.*).

Order MENURIFORMES.

Menura superba (No. 374).—Larvae of a Muscid fly subcutaneously (*Gilbert*, Emu, xix., 1919, p. 48).

Order PASSERIFORMES.

Stipiturus malachurus (No. 545).—Ornithomyia stipituri, *Schiner* (Zool. Voy. Novara, 1850) (*vide* Froggatt, *loc. cit.*).

Glyciphila fulvifrons (No. 629).—Larvae of a Muscid fly subcutaneously (*Gilbert*, *loc. cit.*, p. 49).

Meliornis novae-hollandiae (No. 668).—Larvae of a Muscid fly subcutaneously (*Gilbert*, *loc. cit.*, p. 49).

Meliornis sericea (No. 669).—Larvae of a Muscid fly subcutaneously (*Gilbert*, *loc. cit.*, p. 48).

Anthus australis (No. 687).—Fly larvae attached to body (*Harvey*, Emu, xix., 1919, p. 40; Q'land).

Mr. Froggatt also states that Hippoboscid flies occur on our fruit-pigeons, swallows, and fly-catchers.

7. Mallophaga.(6)

Order CASUARIIFORMES.

Dromaius novae-hollandiae (No. 1).—Degeeriella asymmetrica (*Nitzsch*) (syn. Nirmus setosus, *Le Souëf* and *Bullen*) (Q'land, N.S. Wales, Vict.).

Order GALLIFORMES.

Catheturus lathami (No. 7).—Goniocotes fissus, *Rud.* (from Talegallus lathami); G. macrocephalus, *Taschenb.* (from T. lathami); Lipeurus ischnocephalus, *Taschenb.* (from T. lathami); L. crassus, *Rud.*

Synoicus australis (No. 9).—Goniodes elongatus, *Piaget* (Vict.); G. retractus, *Le Souëf* (Vict.).

Excalfactoria australis (No. 10).—Lipeurus acuminatus, *Piaget*; Goniodes elongatus, *Piaget* (syn. G. longus, *Le Souef*); Menopon pallipes, *Piaget*.

Order COLUMBIFORMES.

Megaloprepia magnifica (No. 21).—Esthiopterum columbae (L.) (syn. Lipeurus baculus, *Nitzsch*, and N. angustus, *Rud.*) (from Carpophaga magnifica).

Macropygia phasianella (No. 25).—Colpocephalum albidum, *Giebel* (from Columba phasianella).

Phaps chalcoptera (No. 30).—Goniocotes flavus (*Rud.*); Esthiopterum columbae (L.) (Tas.); Colpocephalum albidum, *Giebel*.

Leucosarcia pictata (No. 40).—Esthiopterum columbae (L.) (from Leucosarca plicata).

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(6) These records are compiled almost entirely from Prof. V. L. Kellogg's article "Mallophaga" in Wytman's "Genera Insectorum," 1908, from Johnston and Harrison's "Census of Australian Mallophaga" in Proc. Roy. Soc. Q'land, xxiv., 1912, and particularly from Harrison's "Census of Mallophaga in Parasitology," ix., 1916, pp. 1-152. Full references are only given for species not included in these lists. In many cases, though the host occurs in Australia, the parasite has not actually as yet been recorded for this country. Australian occurrences are indicated.

Order RALLIFORMES.

Rallina tricolor (No. 44).—Rallicola bisetosa *(Piaget)* (syn. Oncophorus bisetosus, *Piaget)*.

Tribonyx ventralis (No. 52).—Goniodes cornutus, *Rud.* (straggler; L. H.).; Philopterus flavopunctatus, *Rud.*

Porphyrio melanonotus (No. 55).—Rallicola (Oncophorus) fallax *(Piaget)* (from Porphyrio melanotus, Australia).

Order SPHENISCIFORMES.

Eudyptula minor (No. 62).—Austrogoniodes waterstoni, *Cummings* (Bull. Ent. Rev., v., 1914, p. 173, f. 8).

Order PROCELLARIIFORMES.

Ossifraga gigantea (No. 85).—Esthiopterum obscurum *(Rud.)* (syn. Lipeurus melanocnemis *Giebel)* (from Procellaria gigantea).

Daption capensis (No. 86).—Esthiopterum (Lipeurus) gurlti *(Taschenb.)* (from Procellaria capensis); E. nigrolimbatum *(Giebel)* (syn. E. mutabile, *Piaget)*; E. fuliginosum, *Taschenb.* (syn. E. testaceum, *Taschenb.)*; Ancistroma vagelli, *Fabr.* (syn. A. procellariae, *Westwood)*, N.S. Wales.

Diomedea exulans (No. 94).—Docophoroides brevis, *Dufour* (syns. D. dentatus, *Giebel*, and D. taurus, *Nitzsch)*; Esthiopterum pederiforme, *Dufour* (syns. Docophorus thoracicus, *Nitzsch*; Nirmus angulicollis, *Giebel*; and L. breviceps, *Piaget)*; E. hyalineum *(Neum.)*; E. fuliginosum, *Taschenb.* (syn. Lipeurus fuliginosus, *Taschenb.)*; Menopon affine, *Piaget.*

Diomedea chlororhynchus (No. 98).—Esthiopterum (Lipeurus) fuliginosus, *Taschenb.*

Order LARIFORMES.

Sterna cristata (No. 107).—Colpocephalum crassipes, *Piaget* (from S. poliocera = S. bergii = this species).

Order CHARADRIIFORMES.

Tringa canutus (No. 164).—Degeeriella (Nirmus) holopaea *(Nitzsch)*.

Parra gallinacea (No. 168).—Parricola sulcata, *Piaget* (syn. Oncophorus sulcatus, *Piaget)*.

Order GRUIFORMES.

Antigone australasiana (No. 174).—Philopterus integer, *Nitzsch* (syn. Docophorus integer, *Nitzsch)*; Philopterus novae-hollandiae, *Giebel* (syn. D. novae-hollandiae, *Giebel)*; Esthiopterum (Lipeurus) giganteum *(Le Souëf* and *Bullen)* Q'land, N.S. Wales, Vict.); E. (Lipeurus) gruis (L.) (syn. L. hebraeus, *Nitzsch)* (Q'land, N.S. Wales, Vict.).

Order ARDEIFORMES.

Ibis molucca (No. 175).—Esthiopterum ibidis, *Harris.* (syn. Lipeurus ibis, *Le Souëf* and *Bullen*, from Threskiornis strictipennis, Australia).

Platibis flavipes (No. 179).—Ornithobius fuscus, *Le Souëf* (? a straggler).

Xenorhynchus asiaticus (No. 180).—Philopterus horridus, *Giebel* (from Ciconia australis).

Ardea cinerea (No. 182).—Colpocephalum decimfasciatum, *Bois.* and *Lacord.* (syn. C. importunum, *Nitzsch)*; Esthiopterum ardeae (L.) (syn. Lipeurus leucopygus, *Nitzsch)*.

Notophoyx novae-hollandiae (No. 185).—Philopterus longipes, *Rud.*; Esthiopterum (Lipeurus) unguiculatum *(Piaget)* (from Herodias novae-hollandiae).

Order ANSERIFORMES.

Chenopis atrata (No. 198).—Esthiopterum megacerus, *Jnstn.* and *Harris.* (syns. Lipeurus anatis megaceros, *Jnstn.* and *Harris.*, and L. squalidus, *Nitzsch*, var. attenuata, *Piaget)*; Ornithobius fuscus, *Le Souëf* (Vict.); Trinoton nigrum, *Le Souëf* (Vict.); Colpocephalum castaneum, *Piaget* (from Cygnus atratus).

Anseranas melanoleuca (No. 199).—Heteroproctus hilli, *Harrison* (Parasit., vii., 1914-5, p. 394) (Northern Territory).

Cereopsis novae-hollandiae (No. 202).—Esthiopterum australe *(Rud.)* (syn. Lipeurus australis, *Rud.)*.(from Coreopsis novaehollandiae).

Nettium gibberifrons (No. 210).—Esthiopterum crassicorne *(Scopoli)* (syns. Lipeurus anatis major, *Piaget*, and L. squalidus, *Nitzsch*, var. major, *Piaget* (from Anas gibberifrons).

Nyroca australis (No. 216).—Esthiopterum crassicorne *(Scopoli)* (syn. E. nyrocae [*Rud.*]).

Order PELECANIFORMES.

Phalacrocorax carbo (No. 219).—Degeeriella (Nirmus) interrupta, *Piaget*; Esthiopterum mergiserrati, *Degeer* (syn. Lipeurus temporalis, *Nitzsch)*; E. longicorne *(Piaget)*; E. toxocerum *(Nitzsch)*; Menopon brevipalpe, *Piaget*.

Phalacrocorax sulcirostis (No. 220).—Esthiopterum (Lipeurus) setosum *(Piaget)*; E. confuscum, *Bag.* and *Hall* (syn. E. brevicorne, *Piaget)*; E. acutifrons *(Rud.)* (syn. E. dispar, *Piaget)*; Menopon subrotundum, *Piaget*.

Sula australis (No. 225).—Philopterus (Docophorus) brevianten-natus *(Piaget)*; Eschiopterum (Pectinopygus, Lipeurus) gyricornis *(Denny)*; Menopon albescens, *Piaget*.

Order ACCIPITRIFORMES.

Haliaetus leucogaster (No. 246).—Colpocephalum flavescens, *Nitzsch*.

Order PSITTACIFORMES.

Trichoglossus swainsoni (No. 274) (T. novae-hollandiae).—Eomenopon denticulatum, *Harrison* (Parasit., vii., 1914-5, p. 385) (N.S. Wales); Psittaconirmus australis, *Harrison (loc. cit.*, p. 403) (N.S. Wales).

Ptilosclera versicolor (No. 277).—Eomenopon denticulatum, *Harrison (loc. cit.)* (N.S. Wales).

Glossopsitta porphyrocephala (No. 279).—Psittaconirmus australis, *Harrison (loc. cit.)* (W. Austr.).

Microglossus aterrimus (No. 283).—Menopon commissum, *Neum.*; Degeeriella (Nirmus) paraboliceps *(Piaget)* (from Psittacus aterrimus); Colpocephalum temporale, *Piaget* (from Macroglossus aterrimus).

Calyptorhynchus leachi (No. 289).—Esthiopterum (Lipeurus) circumfasciatum *(Piaget)* (from Colyptorhynchus leachi).

Cacatua galerita (No. 291).—Esthiopterum capreolum, *Gervais* (syn. Lipeurus albus, *Le Souef* and *Bullen)* (Australia).

Cacatua roseicapilla (No. 295).—Degeeriella eos *(Rud.)* (syns. Nirmus eos, *Rud.*, and N. tenuis, *Rud,)* (from Plictolophus (Psittacus) roseocapillus and Cacatua (Psittacus) eos).

Calopsitta novae-hollandiae (No. 298).—Paragoniocotes fasciatus, *Piaget* (from Nymphicus novae-hollandiae).

Polytelis barrabandi (No. 299).—Philopterus (Docophorus) angustoclypeatus *(Piaget)* (from Platycercus barrabandi); P. (D.) forficula *(Piaget)* (from Platycercus barrabandi); Colpocephalum trimaculatum, *Piaget* (from Platycercus barrabandi).

Polytelis melanura (No. 300).—Esthiopterum (Lipeurus) circumfasciatum *(Piaget)* (from Platycercus melaneura).

Aprosmictus scapulatus (No. 303).—Philopterus forficula *(Piaget)* (syn. Docophorus forficula, *Piaget)* (from Platycercus scapulatus).

Platycercus pennanti (No. 304).—Philopterus (Docophorus) forficula *(Piaget)*.

Platycercus pallidiceps (No. 308).—Colpocephalum trimaculatum, *Piaget* (from Platycercus palliceps).

Platycercus eximius (No. 311).—Philopterus (Docophorus) forficula *(Piaget)*; Menopon pteropsittacus, *Harris.* (syn. M. psittacus, *Le Souëf* and *Bullen)* (Australia).

Barnardius barnardi (No. 315).—Philopterus forficula *(Piaget)* (from Platycercus baueri and P. zonarius).

Pezoporus formosus (No. 334) (P. terrestris).—Degeeriella divergens, *Neum.*

Order CORACIIFORMES.

Dacelo gigas (No. 345).—Philopterus (Docophorus) delphax *(Nitzsch)* (from Dacelo gigantea); Degeeriella (Nirmus) bracteata *(Nitzsch)* (from Dacelo gigantea); D. (Nirmus) goniocotes *(Piaget)* (Madagascar); Menopon infumatum, *Piaget* (Madagascar).

Order COCCYGES.

Cacomantis flabelliformis (No. 362).—Philopterus (Docophorus) laticlypeatus *(Piaget)* (from Cuculus flabelliformis, New Holland).

Scythrops novae-hollandiae (No. 372).—Philopterus acutus, *Rud.*; P. (Docophorus) obcordatus *(Piaget)*; Degeeriella lipeuriformis *(Rud.)* (syns. Nirmus lipeuriformis, *Rud.*; N. chelurus, *Nitzsch)*; Myrsidea (Menopon) platygaster *(Giebel)*.

Order MENURIFORMES.

Menura superba (No. 374).—Degeeriella menuraelyrae *(Coinde)* (syns. Philopterus (Docophorus) paraboliceps *(Piaget)*; Nirmus submarginellus, *Nitzsch*; N. submarginalis, *Burm.*; and N. menura, *Le Souëf* and *Bullen)*.

Johnston and Harrison consider Kellogg's record of Degeeriella (Nirmus) marginalis, *Nitzsch*, as an error.

Menura victoriae (No. 375).—Esthiopterum menura, *Le Souëf* and *Bullen* (syn. Lipeurus menura, *Le Souëf* and *Bullen)* (Vict.); Menopon menura, *Le Souef* and *Bullen* (Vict.); Degeeriella menuraelyrae *(Coinde)* (syns. see above) (Vict.).

Order PASSERIFORMES.

Fam. Dicaeidae.

Pardalotus punctatus (No. 606).—Menopon sp., *Giebel.*

Fam. Meliphagidae.

Glyciphila fasciata (No. 631).—Goniocotes candidus, var. pellucidus, *Piaget* (probably a straggler; J. and H).

Tropidorhynchus corniculatus (No. 684).—Eomenopon denticulatus, *Harrison* (Parasitol., vii., 1914-5, p. 385) (N.S. Wales; straggler on this host).

Fam. Ploceidae.

Poephila gouldiae (No. 709) (P. mirabilis).—Machaerilaemus latifrons, *Harrison* (Parasitol., vii., 1914-5, p. 390).

Fam. Ptilonorhynchidae.

Ptilonorhynchus holosericeus (No. 718).—Menopon ptilonorhynchi, *Ponton;* Philopterus ptilonorhynchi, *Ponton* (syn. Docophorus grandiceps *(Nitzsch)* (from Ptilonorhynchus holosericeus); Degeeriella pontoni, *Jnstn.* and *Harrison* (syn. Nirmus nitzschi, *Ponton)* (from Ptilonorhynchus holosericeus).

Sericulus chrysocephalus (No. 726).—Degeeriella (Nirmus) hectica *(Nitzsch).*

Fam. Corvidae.

Strepera graculina (No. 735).—Colpocephalum vinculum, *Le Souëf* and *Bullen* (Australia).

Gymnorhina tibicen (No. 747).—Degeeriella bimaculata *(Piaget)* (syn. Nirmus bimaculatus, from Baryta tibicen).

Gymnorhina leuconota (No. 750).—Degeeriella semiannulata *(Piaget),* (syn. Nirmus semiannulatus, *Piaget,* from Baryta leuconota); Degeeriella (Nirmus) varia, *Nitzsch* (probably a stray, Rotterdam).

8. Acarina.

(a) Super-family IXODOIDEA.

Host probably birds (marine).—Ixodes tasmani, *Neum.* Collected by Verreaux, the ornithologist (1847) in Tasmania *(vide* Nutt. and Warb., Ticks, pt. ii., 1911, p. 245).

Host marine birds.—Ixodes putus *(Pickh.-Cambridge).* Recorded by Neumann from King Island (Tas. ?) *(vide* Nutt. and Warb., Ticks. pt. ii., 1911, p. 261).

Order PASSERIFORMES.

Fam. Hirundinidae.

Petrochelidon ariel (No. 387) (Lagenoplastes ariel).—Argas lagenoplastes, *Frogg.* (Proc. Linn. Soc. N.S. Wales, 1906, p. 408). Recorded for Merriwa and Narromine, N.S. Wales, and for Q'land.

(b) Super-family ORIBATOIDEA.

Fam. Analgesidae ("Bird Mites").

[For the following records, I am indebted to Mr. W. J. Rainbow's "A Synopsis of Australian Acarina" (Rec. of Austr. Mus., vol. vi., pt. 3, p. 181), where the full references will be found.]

Order CHARADRIIFORMES.

Lobivanellus lobatus (No. 128).—Trouessartia caudacuta, *Troues.*

Order ARDEIFORMES.

Ibis molucca (No. 175).—Freyana (Eufreyana) tarandus, *Troues et Neum.;* Alloptes corymbophorus, *Troues et Neum.*

Order ACCIPITRIFORMES.

Haliastur leucosternus (No. 247) (H. indicus, var. girrenera).—Pterolichus (Eupterolichus) phylloproctus, var. minor, *Mégn. et Troues;* P. (Pseudalloptes) aquilinus, var. milvulina, *Troues.*

Order PSITTACIFORMES.

Trichoglossus swainsoni (No. 274) (T. novae-hollandiae).—Pterolichus (Protolichus) brachiatus, var. crassior, *Troues.*

Glossopsitta concinna (No. 278).—Pterolichus (Protolichus) brachiatus, var. crassior, *Troues;* P. (Protolichus) falculiger, *Troues;* P. (Pseudalloptes) cultriventris, *Troues.*

Microglossus aterrimus (No. 283).—Pterolichus (Protolichus) favettei, *Troues.*

Calyptorhynchus macrorhynchus (No. 287).—Pterolichus (Pseudalloptes) spathuliger, *Troues.*

Platycercus pennanti (No. 304).—Pterolichus (Protolichus) chiragricus, *Mégn. et Troues;* Protalges cartus, *Troues.*

Platycercus flaveolus (No. 306).—Pterolichus (Protolichus) chiragricus, *Mégn. et Troues;* P. (Protolichus) veliger, *Mégn. et Troues.*

Psephotus xanthorrhous (No. 319A).—Pterolichus (Protolichus) favettei, *Troues.*

Psephotus haematonotus (No. 324).—Analges tetracentrus, *Troues.*

Melopsittacus undulatus (No. 333).—Pterolichus (Protolichus) lunula, *Robin.*

Pezoporus formosus (No. 334) (P. terrestris).—Pterolichus (Protolichus) chiragricus, *Mégn. et Troues.*

Order MENURIFORMES.

Menura superba (No. 374).—Alloptes major, *Troues.*

Order PASSERIFORMES.

Fam. DICAEIDAE.

Dicaeum hirundinaeeum (No. 602).—Alloptes securiger, *Troues.*

Fam. MELIPHAGIDAE.

Glycyphila fasciata (No. 631).—Protalges australis, *Troues;* Pterodectes manicatus, *Troues.*

Meliornis sericea (No. 669).—Alloptes lobulatus, *Troues.*

Fam. PTILONORHYNCHIDAE.

Sericulus chrysocephalus (No. 726) (S. melinus).—Pterodectes paradisiacus, *Troues.*

9. Haematozoa (7)

(a) HAEMOSPORIDIA.

Order GALLIFORMES.

Catheturus lathami (No. 7).—Halteridium sp.

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(7) For references, *vide* footnote to List of Recorded Cestodes of Australian Birds.

Order COLUMBIFORMES.

Lamprotreron superba (No. 20).—Haemoproteus (Halteridium) columbae (No. 20), *Celli et Fel.*, *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 38).

Order ARDEIFORMES.

Notophoyx novae-hollandiae (No. 185).—Haemoproteus (Halteridium danilewskyi, *Grassi et Fel.*, *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 38).

Order ANSERIFORMES.

Chenopis atrata (No. 198).—Proteosoma biziurae, *Gilr.*, *Sweet et Dodd*, ? *Clel.* (Trans. Roy. Soc. S. Austr., xxxix., 1915, p. 27).
Nettium castaneum (No. 209).—Halteridium sp.
Biziura lobata (No. 218).—Proteosoma biziurae.

Order ACCIPITRIFORMES.

Haliastur leucosternus (No. 247) (H. girrenera).—Haemoproteus (Halteridium) danilewskyi, *Grassi et Fel.*, *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 38).
Falco hypoleucos (No. 256).—Plasmodium (Proteosoma) praecox, *Grassi et Fel.*, *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 34).

Order STRIGIFORMES.

Ninox boobook (No. 263).—Halteridium sp.; Haemoproteus (Halteridium) noctuae, *Celli et Fel.*, *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 37).
Ninox strenua (No. 268).—Halteridium sp., *Clel.* (Trans. Roy. Soc. S. Austr., xxxix., 1915, p. 29).

Order PSITTACIFORMES.

Platycercus adelaidae (No. 305).—Halteridium sp.

Order CORACIIFORMES.

Sub-order PODARGI.

Podargus strigoides (No. 337).—Leucocytozoon sp., *Clel.* (Trans. Roy. Soc. S. Austr., xxxix., 1915, p. 30).

Sub-order HALCYONES.

Dacelo gigas (No. 345).—Halteridium sp.

Sub-order MEROPES.

Merops ornatus (No. 352).—Halteridium sp.

Order COCCYGES.

Eudynamis cyanocephala (No. 371).—Haemoproteus danilewskyi, *Grassi et Fel*, *Breinl (loc. cit.)*.

Order PASSERIFORMES.

Fam. MUSCICAPIDAE.

Microeca fascinans (No. 388).—Halteridium sp.
Petroica phoenicea (No. 393).—Halteridium sp.
Gerygone albogularis (No. 402).—Halteridium sp., *Clel.* (Trans. Roy. Soc. S. Austr., vol. xxxix., 1915, p. 29).
Myiagra nitida (No. 446).—Halteridium sp.

Fam. TIMELIIDAE.

Pomatorhinus superciliosus (No. 479).—Halteridium sp.

Fam. TURDIDAE.

Oreocincla lunulata (No. 488).—Halteridium sp.

Fam. SYLVIIDAE.

Megalurus gramineus (No. 496).—Haemoproteus danilewskyi, *Grassi et Fel., Breinl (loc. cit.).*

Fam. ?

Grallina picata (No. 575).—Halteridium sp.
Corcorax melanorhamphus (No. 577).—Leucocytozoon anellobiae.

Fam. PARIDAE.

Aphelocephala leucopsis (No. 578).—Halteridium sp.

Fam. ZOSTEROPIDAE.

Zosterops dorsalis (No. 599).—Halteridium sp.

Fam. DICAEIDAE.

Dicaeum hirundinaceum (No. 602).—Halteridium sp., *Clel.* (Trans. Roy. Soc. S. Austr., xxxix., 1915, p. 29).
Pardalotus melanocephalus (No. 609).—Halteridium sp., *Clel.* and *Jnstn.* (Jour. and Proc. Roy. Soc. N.S. Wales, xlv., 1911, p. 418).

Fam. MELIPHAGIDAE.

Melithreptus brevirostris (No. 619).—Halteridium sp.
Myzomela sanguineolenta (No. 622).—Halteridium sp.; Leucocytozoon anellobiae.
Ptilotis fusca (No. 643).—Halteridium sp.; Leucocytozoon anellobiae.
Ptilotis sonora (No. 646).—Halteridium sp.
Ptilotis chrysops (No. 648).—Halteridium sp.
Ptilotis plumula (No. 658).—Halteridium sp.
Ptilotis penicillata (No. 661).—Halteridium sp., *Clel.* (Trans. Roy. Soc. S. Austr., xxxix., 1915, p. 30).
Meliornis novae-hollandiae (No. 688).—Halteridium sp.
Myzantha garrula (No. 672).—Halteridium sp.; Leucocytozoon anellobiae.
Myzantha flavigula (No. 674).—Halteridium sp.
Anellobia mellivora (No. 677).—Leucocytozoon anellobiae; Haemoproteus (Halteridium) danilewskyi, *Grassi et Fel., Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 38).
Acanthogenys rufigularis (No. 679).—Halteridium sp., *Clel.* (Trans. Roy. Soc. S. Austr., xxxix., 1915, p. 30); Leucocytozoon sp., *Clel. (loc. cit.,* p. 31).
Entomyza cyanotis (No. 680).—Halteridium sp.; Leucocytozoon anellobiae.
Tropidorhynchus corniculatus (No. 684).—Halteridium sp.; Haemoproteus (Halteridium) danilewskyi, *Grassi et Fel., Breinl* (Austr. Inst. Trop. Med., 1911, p. 37); Leucocytozoon sp. *(Breinl,* etc., p. 37).

Fam. ORIOLIDAE.

Oriolus viridis (No. 712).—Halteridium sp.; Leucocytozoon anellobiae.
Sphecotheres maxillaris (No. 714).—Leucocytozoon anellobiae.

Fam. DICRURIDAE.

Chibia bracteata (No. 716).—Haemoproteus (Halteridium) danilewskyi, *Grassi et Fel.*, *Breinl* (Austr. Inst. Trop. Med., 1911, p. 38).

Fam. PTILONORYHNCHIDAE.

Chlamydera orientalis (No. 724A).—Haemoproteus (Halteridium) danilewskyi, *Grassi et Fel.*, *Breinl* (Austr. Inst. Trop. Med., 1911, p. 38).

Fam. CORVIDAE.

Cracticus destructor (No. 745).—Haemoproteus (Halteridium) danilewskyi, *Grassi et Fel.*, *Breinl (loc. cit.)*.

(b) HAEMOFLAGELLATES.

Order ARDEIFORMES.

Notophoyx novae-hollandiae (No. 185).—Trypanosoma notophoyxis, *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 33).

Order ACCIPITRIFORMES.

Haliastur leucosternus (No. 247) (H. girrenera).—Trypanosoma avium, *Dan.* (T. majus, *Dan.)*, *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 31).

Falco hypoleucos (No. 256).—Trypanosoma avium, *Dan.*, *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 31).

Order STRIGIFORMES.

Ninox boobook (No. 263).—Trypanosoma sp., *Breinl* (Austr. Inst. Trop. Med., Rep. for 1911, p. 34).

Order PASSERIFORMES.

Fam. MUSCICAPIDAE.

Microeca fascinans (No. 388).—Trypanosoma anellobiae.

Fam. MELIPHAGIDAE.

Myzomela sanguineolenta (No. 622).—Trypanosoma sp., *Clel.* (Trans. Roy. Soc. S. Austr., xxxix., 1915, p. 31).

Ptilotis fusca (No. 643).—Trypanosoma anellobiae.

Ptilotis chrysops (No. 648).—Trypanosoma sp., *Clel.* (Trans. Roy. Soc. S. Austr., xxxix., 1915, p. 32).

Anellobia mellivora (No. 677) (A. chrysoptera).—Trypanosoma sp.

Entomyza cyanotis (No. 680).—Trypanosoma sp.

Fam. ORIOLIDAE.

Oriolus viridis (No. 712).—Trypanosoma sp.

Fam. PTILONORHYNCHIDAE.

Chlamydera orientalis (No. 724A).—Trypanosoma chlamydoderae, *Breinl* (Aust. Inst. Trop. Med., Rep. for 1911, p. 32).

VARIOUS PASSING RECORDS.

Eudyptula minor (No. 62).—Nicholls (Emu, xvii., 1918, pp. 129, 130) records the following parasites as present in or on four birds, *viz.*:—(1) Round worms in upper part of stomach, fleas; (2) worms, lice, and fleas; (3) small round worms, lice; (4) worms, lice.

Phalacrocorax hypoleucus (No. 222).—In three of twelve birds examined in South Australia in March, 1917, parasitic worms were noted by Capt. S. A. White (Emu, April, 1918, pp. 214, 215). Capt. White exhibited two tubes of parasitic worms—one from a cormorant's stomach, the other from the thick coating of fat covering the abdomen—at a meeting of the Royal Society of South Australia (Trans., etc., 1916, p. 590).

Ninox rufa (No. 269).—Dr. MacGillivray found parasites under the skin of the head and orbit, N. Queensland (Emu. April, 1918, p. 186).

Podargus marmoratus (C.L. 339) (Micropodargus ocellatus marmoratus).—Tapeworm in subcutaneous tissue of the abdomen, N. Queensland, MacGillivray (Emu, April, 1918, p. 189).

H. L. White, in "North Australian Birds observed by Wm. McLennan" (Emu, xvi., pt. iv., pp. 205-230), mentions the finding of the following parasites:—

Turnix castanota (No. 14).—Small worms in chest, abdominal cavity, and eye socket. King River.

Falco lunulatus (No. 258).—Tapeworms in a mass of yellow pus, and a growth containing pus and worms on the left leg. Very small worms in the eye socket and membrane. A short, thick, round worm in the abdominal cavity. A mass of long, thin, round worms over the kidneys and testes; the testes almost totally destroyed. Some of the worms over 6 ins. long. Mornington Island, July, 1915.

Ninox boobook (No. 263).—A mass of worms in the inflamed fibrous membrane on the skull between the eyes; two more in the left eye socket and one in the abdominal cavity.

Ninox connivens (No. 267).—Several worms under the skin of the body and legs.

Ninox rufa (No. 269).—Numerous tapeworms under the skin of the legs. A round worm in the left eye.

Trichoglossus rubritorques (No. 275).—A number of large tapeworms in the abdominal cavity.

Halcyon sanctus (No. 349).—Two large and two small worms in the neck. One large worm in the abdominal cavity.

Graucalus melanops (No. 457).—Small worms in the nictitating membrane. Large tapeworms in the intestine.

Graucalus hypoleucus (No. 458).—Worms under the skin of the thighs.

Colluricincla brunnea (No. 568).—Small worms in the eye membrane and larger ones in the liver. King River.

Colluricincla woodwardi (No. 571).—Worms under the skin. King River.

Philemon sordidus (No. 685A).—A number of worms in the abdominal cavity.

Oriolus flavicinctus (No. 713).—Two small worms in the abdominal cavity.

PT. II.—PARASITES OF AUSTRALIAN BIRDS THAT HAVE COME UNDER THE WRITER'S NOTICE.

1. Cestodes.

Chalcophaps chrysochlora (No. 29).—Stradbroke Island, Q'land, Sept., 1919.

Phaps elegans (No. 31).—Waitpinga, Encounter Bay, Jan., 1922

Podiceps poliocephalus (No. 58).—Muswellbrook, Feb. (Dr. Darnell Smith), cestodes in intestines, the largest in subperitoneal tissue(?), probably from injury.

Eudyptula minor (No. 62).—Encounter Bay, Feb., 1921, numerous cestodes in intestines, bird thin; and Jan., 1922 (2, 1 nil, 1 with cestodes).

Puffinus sphenurus (No. 69).—Little Bay, Sydney, Dec., 1914 (washed up dead).

Puffinus griseus (No. 72).—Washed ashore near Manly, Oct., 1916.

Puffinus brevicaudus (No. 74).—Flinders Island, Nov., 1912 (4 birds, 3 nil).

Sterna cristata (No. 107).—Encounter Bay, Jan., 1922.

Pisobia acuminata (No. 162).—Gular, Oct., 1911 (2 birds).

Gallinago australis (No. 166).—Mannum, S. Austr., Nov., 1913.

Chenopis atrata (No. 198).—In captivity, Coast Hospital, Sydney, April, 1916, numerous cestodes; Zool. Gardens, Sydney, Mar., 1915.

Anas superciliosa (No. 208).—Deniliquin, Mar., 1918 (J. Weir, per W. W. Froggatt); N.S. Wales (ova in tumours of intestine, (?) nematode or cestode, from Dr. Darnell-Smith).

Teal.—Cobar, Dec., 1911.

Hieracidea berigora (No. 259).—Flinders Island, Nov., 1912, cestode(?) (with nematodes in crop and stomach).

Ninox boobook (No. 263).—Mannum, S. Austr., Nov., 1913; Flinders Island, Nov., 1912; Bunya Mountains, Q'land, Oct., 1919.

Trichoglossus swainsoni (No. 274).—Eidsvold, Q'land, July, 1913 (Dr. T. L. Bancroft); Encounter Bay, Feb., 1921 (nil).

Cacatua galerita (No. 291).—Sydney, in captivity, Aug., 1918.

Barnardius barnardi (No. 315).—Willbriggie, N.S. Wales, Oct., 1912; near Morgan, Nov., 1913 (nil); Beltana, Aug., 1921 (nil).

Podargus marmoratus (No. 339).—Claudie River, N. Q'land, 1913 (Dr. MacGillivray, cestode under skin of abdomen).

Syma flavirostris (No. 344).—N. Q'land, 1913 (Dr. MacGillivray, 2, cestodes in subcutaneous tissues of leg in one).

Halcyon macleayi (No. 347).—Stradbroke Island, Q'land, Sept., 1919.

Pitta strepitans (No. 377).—Bunya Mountains, Q'land, Oct., 1919 (2 with cestodes, 1 nil).

Cheramoeca leucostenum (No. 385).—Narrabri, Feb., 1912 (2).

Petrochelidon nigricans (No. 386).—Stradbroke Island, Q'land, Sept., 1919.

Petrochelidon ariel (No. 387).—Gular, Oct., 1911 (with trematodes); Morgan, 1913 (2 nil).

Eopsaltria chrysorrhoa (No. 419).—Stradbroke Island, Q'land, Sept., 1919; Bunya Mountains, Q'land, Oct., 1919 (nil).

Pachycephala melanura (No. 426).—Stradbroke Island, Q'land, Sept., 1919 (1 cestodes, 2 nil).

Pachycephala rufiventris (No. 430).—Pilliga Scrub, Oct., 1918 (2, 1 nil); Kendall, Jan., 1919 (nil); Stradbroke Island, Q'land, Sept., 1919; Beltana, Aug., 1912 (nil).

Pachycephala olivacea (No. 433).—Flinders Island, Nov., 1912.

Piezorhynchus nitidus (No. 451).—N. Q'land, 1913 (Dr. MacGillivray, larval cestode(?) in subcuteaneous tissues).

Coracina parvirostris (No. 457A).—Flinders Island, Nov., 1912 (small bodies, (?) parasitic).

Hylacola pyrrhopygia (No. 474).—Encounter Bay, Jan., 1912; Bumberry, near Manildra, Jan., 1916 (nil).

Malurus longicaudus (No. 529).—Flinders Island, Nov., 1912 (9, 2 with cestodes, 2 with filaria in peritoneum, 5 nil).

Artamus leucogaster (No. 559).—Stradbroke Island, Q'land, Sept., 1919 (1 cestodes, 1 nil).

Artamus personatus (No. 561).—North of Renmark, Jan., 1921.

Artamus melanops (No. 562A).—Cobar, Oct., 1911; Gunnedah, Sept., 1914 (nil); Beltana, Aug., 1921 (nil).

Artamus sordidus (No. 564).—Hawkesbury River, Oct., 1912 (nil); Manilla, Sept., 1914 (nil); Coonabarabran, Sept., 1914; Upper Manilla, Sept., 1914 (nil); Bibbenluke, N.S. Wales, Mar., 1913 (nil).

Colluricincla harmonica (No. 566).—Hawkesbury River, June, 1912 (nil); Coonabarabran, Sept., 1914 (nil); Encounter Bay, Jan., 1921.

Colluricincla selbii (No. 567).—Flinders Island, Nov., 1912.

Corcorax melanorhamphus (No. 577).—Near Morgan, Nov., 1913; Gunnedah, Sept., 1914 (3, echinorhynchs in 1, nil in 2); Coonabarabran, Sept., 1914; Belaringar, April, 1915 (echinorhynchs and (?) cestodes); Tarcoon, Oct., 1914 (nil); Dubbo, June, 1915 (worms).

Zosterops dorsalis (No. 599).—Sydney, June and July, 1912, and Nov., 1911 (all with cestodes), and Aug., 1911 (1), June, 1912 (4), July, 1912 (11), Aug., 1912 (8), and Dec., 1918 (1) (all nil); Flinders Island, Nov., 1912 (3, 2 with cestodes); Bunya Mountains, Q'land, Oct., 1919 (2 nil); Encounter Bay, Jan. 1921 (nil).

Pardalotus striatus (No. 603).—Near Morgan, Nov., 1913; Alawoona, S. Austr., Dec., 1913; Beltana, Aug., 1921 (nematode in peritoneum only); north of Renmark, Jan., 1921 (nil).

Pardalotus affinis (No. 605) (? all this species).—Flinders Island, Nov., 1912 (4, cestodes in 1, cestodes(?) in 1, nil in 2).

Glyciphila albifrons (No. 630).—Overland Corner, S. Austr., Nov., 1913 (2, 1 nil).

Stigmatops ocularis (No. 639).—Stradbroke Island, Q'land, Sept., 1919 (2 with cestodes, 1 nil).

Ptilotis fusca (No. 643).—Grafton, April, 1912 (2 nil); Molong, Oct., 1913 (nil); Wellington, N.S. Wales, Nov., 1914 (2 nil); Dubbo, July, 1914 (2 nil); French's Forest, Sydney, June, 1915 (nil); Bumberry, near Manildra, Jan., 1916 (cestodes); Bumberry, Oct., 1916 (nil).

Ptilotis auricomis (No. 652).—Hawkesbury River, June, 1912; Molong, Oct., 1913 (nil); Grafton, April, 1912 (nil); Hawkesbury River, April, 1913 (nil).

Ptilotis ornata (No. 656).—Alawoona, S. Austr., Dec., 1913; Monarto South, May, 1921.

Meliornis sericea (No. 669).—Stradbroke Island, Q'land, Sept., 1919 (cestodes in 1, nil in 1).

Myzantha flavigula (No. 674).—Tarcoon, Oct., 1914; Belaringar, April and May, 1915 (both nil).

Acanthogenys rufigularis (No. 679).—Cobar, Oct., 1911 (nematodes only); Yanco, Oct., 1912 (nil); Overland Corner, S. Austr., Nov., 1913; Narrabri, Nov., 1916 (nil).

Entomyza cyanotis (No. 680).—Mannum, Nov., 1913 (2 nil); Bumberry, near Manildra, Jan., 1916.

Anthus australis (No. 687).—Flinders Island, Nov., 1912 (2, 1 nil); West Island, Encounter Bay, Jan., 1922 (nil).

Mirafra horsfieldi (No. 688).—Encounter Bay, Jan., 1922.

Ptilonorhynchus holosericeus (No. 718).—Bunya Mountains, Q'land, Oct., 1919 (cestodes in 1, nil in 5).

Ailuroedus smithi (No. 720).—Mummulgum, near Casino, Dec., 1916; Bunya Mountains, Q'land, Oct., 1919 (2 nil, 2 with cestodes).

Sericulus chrysocephalus (No. 726).—Bunya Mountains, Q'land, Oct., 1919 (cestode in 1, cestode in abdominal cavity (probably from wound) in 1, nil in 4); Mummulgum, near Casino, Dec., 1916 (nil); Zool. Gardens, Sydney, Nov., 1919 (nil).

Corvus coronoides (No. 732) and C. australis (No. 734).—Yanco, Oct, 1912; Flinders Island, Nov., 1912 (1 nil, (?)cestode in 1); Walgett, Sept., 1914 (2 with cestodes); Upper Manilla, Sept., 1914 (nil); Coonabarabran, Sept., 1914 (nil); Moree, Oct., 1914 (2 nil); Tarcoon, Oct., 1914 (nil); Merah, near Moree, Oct., 1914 (2 nil); Belaringar, June, 1915 (3, cestodes in 1); Tarcoon, Oct., 1914 (?sparganum); Bumberry, near Manildra, Jan., 1916.

Corvus cecilae.—Stradbroke Island, Q'land, Sept., 1919 (cestodes in 1, nil in 2).

Strepera graculina (No. 735).—Mount Irvine, June, 1915 (filaria only); Scone, May, 1917 (filaria in 1, nil in 1); Bunya Mountains, Q'land, Oct., 1919 (cestodes only).

2. Nematodes.

Eudyptula minor (No. 62).—Encounter Bay, Feb., 1921 (in stomach), and Jan., 1922 (2, no nematodes).

Pelagodroma marina (No. 65).—Flinders Island, Nov., 1912 (6, nematodes in crop of 1, 5 nil).

Pisobia acuminata (No. 162).—Flinders Island, Nov., 1912 (?nematode in intestine).

Pelecanus conspicillatus (No. 233).—Sep., 1918 (nematodes in stomach).

Astur novae-hollandiae (No. 237).—N. Queensland (Dr. MacGillivray), 1913 (nematode in nictitating membrane of eye).

Falco lunulatus (No. 258).—Flinders Island, Nov., 1912 (filaria in peritoneal cavity).

Hieracidea berigora (No. 59).—Flinders Island, Nov., 1912 (nematodes in stomach and oesophagus, (?)cestodes also).

Ninox rufa (No. 269).—N. Queensland (Dr. MacGillivray), 1913 (3, in orbit of one, orbit and under skin of forehead in another, 2 large flesh-coloured worms in abdominal cavity, and 1 small white worm in chest cavity in third).

Pseudopsittacus maclennani.—N. Queensland (Dr. MacGillivray), 1913 (nematodes in abdominal cavity).

Dacelo gigas (No. 345).—Pilliga Scrub, Oct., 1918 (large nematode in intestine).

Halcyon sanctus (No. 349).—Stradbroke Island, Moreton Bay (?nematodes in intestine and small coiled nematode in peritoneal cavity, from injury to intestine).

Pitta mackloti (No. 378).—N. Queensland (Dr. MacGillivray), 1913.

Petroica phoenicea (No. 393).—Flinders Island, Nov., 1912 (filaria in peritoneal cavity).

Myiagra plumbea (No. 444).—Stradbroke Island, Q'land, Sept., 1919.

Pomatorhinus superciliosus (No. 479).—Baradine, Oct., 1918 (nematode in intestine, also Echinorhynchus pomatostomi, subcutaneously).

Oreocincla macrorhyncha (No. 488A).—Mount Arthur, near Launceston, Tas., Nov., 1912 (?nematode in intestine).

Malurus longicaudus (No. 529).—Flinders Island, Nov., 1912 (9, filaria in peritoneum of 2 birds, cestodes in 2, nil in 5).

Pardalotus striatus (No. 603).—See under Cestodes.

Ptilotis leilavalensis (No. 661A).—Beltana, Aug., 1921 (nematode attached to outer wall of oesophagus).

Myzantha flavigula (No. 674).—North of Renmark, Jan., 1921 (nematodes in pleuro-peritoneal cavity, yellow, as was the fat and skin of the abdomen.

Acanthogenys rufigularis (No. 679).—Cobar, Oct., 1911 (nematode only); Yanco, Oct., 1912 (nil); Overland Corner, S. Austr., Nov., 1912 (cestode only); Narrabri, Nov., 1916 (nil).

Strepera graculina (No. 735).—Mount Irvine, June, 1915 (filaria in peritoneal cavity); Scone, May, 1917 (filaria in pleuro-peritoneal cavity in 1, nil in 1); Bunya Mountains, Q'land, Oct., 1919 (cestodes only).

Domestic pigeons, chiefly squabs about 28 days old.—Numerous small nematodes in intestine, almost blocking it, Sydney, May, 1919; Ascaridea columbae *(Gmelin)* (Heterakis maculosa, *Schn.)*, identified by Miss Irwin Smith.

3. Acanthocephala.

Baza subcristata (No. 254).—Mummulgum, N.S. Wales, Dec., 1916, Centrorhynchus asturinus, *Jnstn.*

Seisura inquieta (No. 443).—Canowindra, 1915 (echinorhynch near rectum).

Cinclosoma cinnamoneum (No. 468).—(?)Locality, larval Echinorhynchus pomatostomi, *C.* and *J.*, in subcutaneous tissue of neck (Dr. MacGillivray).

Psophodes crepitans (No. 476).—Bunya Mountains, Q'land, Oct., 1919.

Pomatorhinus temporalis (No. 478).—Canowindra, 1915 (3, larval E. pomatostomi).

Pomatorhinus superciliosus (No. 479).—Hallett Cove, S. Austr., May, 1910, larval E. pomatostomi subcutaneously; Baradine, Oct., 1918, larval E. pomatostomi subcutaneously (also nematodes in intestine).

Oreocincla lunulata (No. 488).—Bunya Mountains, Q'land, Oct., 1919 (echinorhynchs in 5); Kuitpo, S. Austr., May, 1921, larval E. pomatostomi subcutaneously.

Corcorax melanorhamphus (No. 577).—Near Morgan, Nov., 1913 (cestode only); Gunnedah, Sept., 1914 (3, echinorhynch in 1); Coonabarabran, Sept., 1914 (cestode only); Belaringar, April, 1915 (echinorhynchs and cestodes ?); Tarcoon, Oct., 1914 (nil); Dubbo, June, 1915 (worms).

Aphelocephala leucopsis (No. 578).—Hallett Cove, S. Austr., May, 1910, larval E. pomatostomi subcutaneously; Gular, Oct., 1911 (2 nil); Narrabri, Feb., 1912 (nil); Overland Corner, S. Austr., Dec., 1913 (nil); Mount Lofty Ranges, Nov., 1912 (nil); north of Renmark, Jan., 1921 (nil).

Climacteris scandens (No. 592) (C. picumnus).—Near Morgan, Nov., 1913 (2, larval E. pomatostomi and (?)worm in intestine in 1, nil in 1).

4. Trematodes.

Petrochelidon ariel (No. 387).—Gular, Oct., 1911, type of Plagiorcis clelandi, *S. J. Johnston* (with cestodes in intestines); Morgan, Nov., 1913 (2, both nil).

5. Species of Birds Examined in which Entozoa (excluding Haematozoa) have not been detected by the Writer.

Leipoa ocellata (No. 6).—Zool. Gardens, Sydney (2 birds).
Coturnix pectoralis (No. 8).—Encounter Bay, Jan., 1922 (2).
Turnix varia (No. 13).—Flinders Island, Nov., 1922.
Turnix velox (No. 16).—Near Broken Hill, April, 1917.
Geopelia humeralis (No. 26).—Stradbroke Island, Q'land, Sept., 1919.
Geopelia tranquilla (No. 27).—Coonamble, Aug., 1912; Mannum, S. Austr., Nov., 1913 (2).
Phaps chalcoptera (No. 30).—Overland Corner, S. Austr., Dec., 1913.
Ocyphaps lophotes (No. 39).—Parachilna, Aug., 1921.
Leucosarcia picata (No. 40).—Bunya Mountains, Q'land, Oct., 1919.
Haematopus fuliginosus (No. 126).—Flinders Island, Nov., 1912.
Lobivanellus lobatus (No. 128).—Upper Manilla, Sept., 1914.
Spoonbill (white).—Taronga Zool. Park, June, 1919.
Astur novae-hollandiae (No. 237).—Taronga Zool. Park, April, 1919.
Astur approximans (No. 228).—N.S. Wales, April, 1912.
Uroaëtus audax (No. 243).—Nevertire, Aug., 1919.
Haliastur sphenurus (No. 248).—Coonamble, Aug., 1912; Tarcoon, Oct., 1914.
Calyptorhynchus baudini (No. 284).—Taronga Zool. Park (from W. Austr.), Aug., 1919.
Calyptorhynchus leachi (No. 289).—Narrabri, Nov., 1916 (2 birds); Dorrigo, Jan., 1918.
Cacatua gymnopis (No. 293).—Beltana, Aug., 1921.
Cacatua roseicapilla (No. 295).—Belaringar, April, 1915.
Aprosmictus scapulatus (No. 303).—Bunya Mountains, Q'land, Oct., 1919 (3).
Platycercus pennanti (No. 304).—Wagga, July, 1914 (2); Mount Irvine, June, 1915; Bunya Mountains, Q'land, Oct., 1919 (7).
Platycercus flaveolus (No. 306).—Morgan, S. Austr., Nov., 1913 (3).
Platycercus flaviventris (No. 307).—Flinders Island, Nov., 1913 (4).
Platycercus eximius (No. 311).—Belaringar, May, 1915; Dubbo, July, 1915 (2); Kendall, Aug., 1918.
Psephotus haematogaster (No. 319).—Belaringar, May, 1915.
Psephotus multicolor (No. 323).—North of Renmark, Jan., 1921 (2).
Psephotus haematonotus (No. 324).—Cowra, Sept., 1911; Coonamble, Aug., 1912; Mannum, S. Austr., Nov., 1913 (2); Goolwa, Nov., 1921.
Euphema elegans (No. 327).—Encounter Bay, Jan., 1921, and Jan., 1922.
Euphema pulchella (No. 330).—Narrabri, June, 1919.
Lathamus discolor (No. 332).—Flinders Island, Nov., 1912.
Eurystomus pacificus (No. 341).—Scone, Oct., 1917.
Halcyon pyrrhopygius (No. 348).—Near Morgan, S. Austr., Nov., 1913.
Merops ornatus (No. 352).—Coonabarabran, Sept., 1914.
Cuculus pallidus (No. 361).—N.S. Wales, Nov., 1911.

Cacomantis flabelliformis (No. 362).—Flinders Island, Nov. 1913 (2).
Chalcococcyx basalis (No. 366).—Flinders Island, Nov., 1913; Overland Corner, S. Austr., Dec., 1913.
Eudynamis cyanocephala (No. 371).—Mummulgum, near Casino, Dec., 1916 (2 birds).
Microeca fascinans (No. 388).—Sydney, Nov., 1911; Morgan, S. Austr., Nov., 1913.
Petroica leggii (No. 392).—Flinders Island, Nov., 1911.
Petroica phoenicea (No. 393).—Flinders Island, Nov., 1911.
Petroica goodenovii (No. 394).—Beltana, Aug., 1922.
Erythrodryas rosea (No. 396).—Hawkesbury River, June, 1912.
Melanodryas bicolor (No. 397).—Pilliga Scrub, Oct., 1918; Encounter Bay, Jan., 1921.
Amaurodryas vittata (No. 398).—Flinders Island, Nov., 1911 (2).
Orthonyx spinicaudis (No. 464).—Dorrigo, Jan., 1918 (2 birds).
Smicrornis brevirostris (No. 400).—Morgan, Nov., 1913; Scone, May, 1917; Dubbo, Aug., 1917; Pilliga Scrub, Oct., 1918; north of Renmark, Jan., 1921.
Gerygone albogularis (No. 402).—Molong, Oct., 1913.
Gerygone fusca (No. 405).—Lisarow, May, 1915.
Eopsaltria australis (No. 418).—Molong, Oct., 1913.
Falcunculus frontatus (No. 422).—Mount Irvine, June, 1915.
Oreoica cristata (No. 425).—North of Renmark, Jan., 1921.
Pachycephala gutturalis (No. 428).—Bunya Mountains, Q'land, Oct., 1919 (2); Encounter Bay, Jan., 1922.
Pachycephala glaucura (No. 429).—Flinders Island, Nov., 1912 (3).
Rhipidura diemenensis (No. 436A).—Flinders Island, Nov., 1912 (3).
Rhipidura rufifrons (No. 439).—Mummulgum, near Casino, Dec., 1916; Bunya Mountains, Q'land, Oct., 1919.
Rhipidura motacilloides (No. 442).—Sydney, Nov., 1911.
Monarcha carinata (No. 455).—Bunya Mountains, Q'land, Oct., 1919.
Graucalus melanops (No. 457).—Tarcoon, Oct., 1914; Upper Manilla. Sept., 1914; Beltana, Aug., 1921.
Graucalus parvirostris (No. 457A).—Flinders Island, Nov., 1912 (4).
Graucalus mentalis (No. 459).—Coonabarabran, Sept., 1914.
Campephaga humeralis (No. 462).—Hawesbury River, Oct., 1912; Baan Baa, Jan., 1917 (young bird).
Campephaga leucomela (No. 463).—Stradbroke Island, Q'land, Sep., 1919.
Cinclosoma punctatum (No. 466).—Encounter Bay, Jan., 1922.
Cinclosoma castanonotum (No. 467).—Alawoona, S. Austr., Dec., 1913 (2).
Drymodes brunneopygius (No 472).—Alawoona, S. Austr., Dec., 1913.
Hylacola cauta (No. 475).—Monarto South, S. Austr., May, 1921.
Cincloramphus cruralis (No. 484).—Near Broken Hill, April, 1917.
Cincloramphus rufescens (No. 485).—Pilliga Scrub, Oct., 1918 (2).
Ephthianura albifrons (No. 489).—Flinders Island, Nov., 1913; Encounter Bay, Jan., 1921 (2).
Ephthianura tricolor (No. 490).—Molong, Oct., 1913 (3); Parachilna, S. Austr., Aug., 1921.
Ephthianura aurifrons (No. 491).—Broken Hill, April, 1917; Parachilna, S. Austr., Aug., 1921.
Origma rubricata (No. 500).—Sydney, April, 1912.
Chthonicola sagittata (No. 501).—The Oaks, N.S. Wales, June, 1914; Baan Baa, near, Boggabri, Jan., 1917.

Acanthiza nana (No. 503).—Hawkesbury River, May, 1915; Dubbo, Mar., 1915; Pilliga Scrub, Oct., 1918; Narrabri, June, 1919; Bunya Mountains, Oct., 1919.

Acanthiza reguloides (No. 507).—Bibbenluke, Mar., 1913; Pilliga Scrub, Oct., 1918; Bunya Mountains, Q'land, Oct., 1919.

Acanthiza chrysorrhoa (No. 508).—Scone, May, 1917.

Acanthiza uropygialis (No. 509).—Yanco, Oct., 1912· Mannum, Nov., 1913; Overland Corner, S. Austr., Dec., 1913; Dubbo, July, 1915 (2); Baan Baa, Jan., 1917; Beltana, Aug., 1921; north of Renmark, Jan., 1921.

Acanthiza lineata (No. 511).—Sydney, Nov., 1912; Bell, June, 1915; Bunya Mountains, Oct., 1919; Encounter Bay, Jan., 1921, and Jan., 1922.

Acanthiza pusilla (No. 512).—Kurrajong, Aug., 1912; Bibbenluke, N.S. Wales, Mar., 1913; Bunya Mountains, Q'land, Oct., 1919 (2).

Acanthiza diemenensis (No. 512A).—Flinders Island, Nov., 1913 (2).

Acanthiza pyrrhopygia (No. 516).—Monarto South, S. Austr., July, 1914; Encounter Bay, Feb., 1921.

Acanthiza albiventris (No. 516A).—Pilliga Scrub, Oct., 1918.

Pyrrholaemus brunneus (No. 517).—Renmark, Jan., 1921.

Sericornis citreigularis (No. 518).—Mount Irvine, June, 1915; Bunya Mountains, Q'land, Oct., 1919 (2).

Sericornis frontalis (No. 519).—Lisarow, May, 1915 (2); Mount Irvine, June, 1915; Canobolas, Oct., 1916 (2); Bunya Mountains, Q'land, Oct., 1919.

Sericornis magnirostris (No. 521).—Bunya Mountains, Q'land, Oct., 1919.

Sericornis humilis (No. 524).—Flinders Island, Nov., 1912 (5).

Malurus cyaneus (No. 530).—Sydney, Nov., 1911; Kuitpo, S. Austr , May, 1921.

Malurus cyanochlamys (No. 530A).—Bunya Mountains, Q'land, Oct., 1919 (5).

Malurus melanonotus (No. 532).—Overland Corner, S. Austr., Dec., 1913 (4).

Malurus cyanotus (No. 535).—Beltana, Aug., 1921.

Malurus assimilis (No. 538).—Alawoona, S. Austr., Dec., 1913 (2); Beltana, Aug., 1921.

Malurus melanocephalus (No. 542).—Mummulgum, near Casino, Dec., 1916.

Artamus superciliosus (No. 560).—Cowra, Sept., 1911; Sydney, Oct., 1919.

Colluricincla rufigaster (No. 573).—Stradbroke Island, Sept., 1914 (4).

Grallina picata (No. 575).—Cowra, Sept., 1911; Pennant Hills. Sydney, Dec., 1916 (D. Steel).

Struthidea cinerea (No. 576).—Gunnedah, Sept , 1914 (3); Coonabarabran, Sept., 1914; Belaringar, April, 1915.

Neositta chrysoptera (No. 583).—Hawkesbury River, June, 1912.

Neositta pileata (No. 586).—Encounter Bay, Feb., 1921.

Climacteris picumna (No. 592) (scandens).—Narrabri, Feb., 1912; Molong, Oct., 1913; Baradine, Oct., 1918.

Climacteris leucophaea (No. 593).—Bunya Mountains, Q'land, Oct., 1919.

Pardalotus punctatus (No. 606).—Flinders Island, Nov., 1912.

Pardalotus xanthopygius (No. 607).—Mannum, Nov., 1913.

Pardalotus melanocephalus (No. 609).—Stradbroke Island, Q'land, Sept., 1919.

Melithreptus lunulatus (No. 613).—Sydney, Nov., 1911 (2), and May, 1912; Hawkesbury River, June, 1912 (2); Stradbroke Island, Q'land, Sept., 1919; Kuitpo, S. Austr., May, 1921.

Melithreptus brevirostris (No. 619).—Sydney, April, 1912; Hawkesbury River, June, 1912; Mannum, S. Austr., Nov., 1913 (3); Scone, May, 1917; Bumberry, Oct., 1916; Encounter Bay, Jan., 1921.

Melithreptus melanocephalus (No. 620).—Flinders Island, Nov., 1912.

Myzomela sanguineolenta (No. 622).—Kendall, Jan., 1919.

Myzomela nigra (No. 624).—Molong, Oct., 1913.

Glycyphila fulvifrons (No. 629).—Flinders Island, Nov., 1912 (4); French's Forest, Sydney, June, 1915.

Meliphaga phrygia (No. 638).—Bumberry, Sept., 1916.

Ptilotis chrysotis (No. 644).—Bunya Mountains, Q'land, Nov., 1919.

Ptilotis sonora (No. 646).—Mannum, S. Austr., Nov., 1913; Parachilna, S. Austr., Aug., 1921; Encounter Bay, Jan., 1922.

Ptilotis chrysops (No. 648).—Hawkesbury River, June, 1912; Kurrajong, Aug., 1912; Hawkesbury River, Nov., 1914, and May, 1915.

Ptilotis flavigula (No. 649).—Flinders Island, Nov., 1912 (3).

Ptilotis leucotis (No. 651).—Dubbo, Aug., 1917.

Ptilotis ornata (No. 656).—Morgan, Nov., 1913 (2), Monarto South, S. Austr., July, 1914.

Ptilotis plumula (No. 658).—North of Renmark, Jan., 1921.

Ptilotis penicillata (No. 661).—Narrabri, Feb., 1912; near Morgan, S. Austr., Nov., 1913 (2); Overland Corner, S. Austr., Dec., 1913; Pilliga Scrub, Oct., 1918.

Lichmera australasiana (No. 667).—Flinders Island, Nov., 1912.

Myzantha garrula (No. 672).—Gunnedah, Sept., 1914 (4); Upper Manilla, Sept., 1914; Hawkesbury River, May, 1915; Belaringar, April (2) and May, 1915; Scone, May, 1917.

Anthochaera carunculata (No. 675).—Hawkesbury River, July, 1912 (3); Sept., 1912 (4); Scone, May, 1917.

Tropidorhynchus corniculatus (No. 684).—Hawkesbury River, May, 1915.

Philemon citreogularis (No. 685).—Cowra, Sept., 1911; Dubbo, Aug., 1917.

Zonaeginthus bellus (No. 693).—Flinders Island, Nov., 1912.

Stizoptera bichenovii (No. 697).—Narrabri, June, 1919 (3).

Aegintha temporalis (No. 703).—Gosford, May, 1915 (4); Encounter Bay, Jan., 1922.

Ptiloris paradisea (No. 728).—Bunya Mountains, Q'land, Oct., 1919 (4).

Strepera arguta (No. 736).—Flinders Island, Nov., 1912 (2).

Cracticus destructor (No. 745).—Tarcoon, Oct., 1914.

Gymnorhina tibicen (No. 747).—Upper Manilla, Sept., 1914; Tarcoon, Dec., 1914.

Turtur ferrago (introduced Dove).—Sydney, Nov., 1911, and Mar., 1917.

Sturnus vulgaris (Starling).—Gunnedah, Sept., 1914 (5, young); Wagga, Aug., 1914 (2).

Passer domesticus (Sparrow).—Sydney, Nov., 1911, and June, 1917.

6. Siphonaptera (Fleas).

Eudyptula minor (No. 62).—Bird Island, Rockingham, W. Austr., Nov., 1906 (Parapsyllus australiacus, *Rothsch.*, Nov. Zool., xvi., 1909, p. 62, *in cop.)*; Flinders Island, Nov., 1912 (P. australiacus, determined by N. C. Rothschild); Encounter Bay, Feb., 1921 (no fleas, mallophaga), and Jan., 1922 (no fleas, mallophaga).

Puffinus brevicaudus (No. 74).—Flinders Island, Nov., 1912 (P. australiacus, *Rothsch.*; doubtful as to whether a stray).

7. Diptera.

Petrochelidon ariel (No. 387).—Near Morgan, S. Austr., Nov., 1913 Ornithomyia australasiae *Leach(?)*, identified at British Museum).

8. Mallophaga.

Coturnix pectoralis (No. 8).—Encounter Bay, Jan., 1911 (1 nil, 1 mallophaga on wings).

Turnix velox (No. 16).—Near Broken Hill, April, 1917.

Phaps elegans (No. 31).—Waitpinga, Encounter Bay, Jan., 1922.

Eudyptula minor (No. 62).—See under Siphonaptera.

Pelagodroma marina (No. 65).—Flinders Island, Nov., 1912 (1 mallophaga, 1 nil).

Puffinus sphenurus (No. 69).—Little Bay, Sydney, Dec., 1914 (washed ashore).

Puffinus brevicaudus (No. 74).—Flinders Island, Nov., 1912 (2).

Prion banksi (No. 89).—Cronulla, Aug., 1911 (washed up).

Sterna cristata (No. 107).—Encounter Bay, Jan., 1922.

Haematopus fuliginosus (No. 126).—Flinders Island, Nov., 1912 (1 mallophaga, 1 nil).

Lobivanellus lobatus (No. 128).—Upper Manilla, Sept., 1914 (mallophaga and mites).

Himantopus leucocephalus (No. 142).—(?)Locality (Dr. D'Ombrain).

Pisobia acuminata (No. 162).—Gular, Oct., 1911; Flinders Island, Nov., 1912 (nil); Cape York or south-west of Queensland, Dec., 1912 (Dr. MacGillivray).

Rhynchaea australis (No. 167).—Cape York or south-west of Queensland, Dec., 1912 (Dr. MacGillivray).

Chenopis atrata (No. 198).—In captivity, Coast Hospital. Sydney, April, 1916; Zool. Gardens, Sydney.

Cereopsis novae-hollandiae (No. 202).—Cape Barren Island, Bass Straits, Nov., 1912.

Astur approximans (No. 238).—N.S. Wales, April, 1912.

Uroaëtus audax (No. 243).—Nevertire, Aug., 1919.

Haliastur sphenurus (No. 248).—Coonamble, Aug., 1912; Tarcoon, Oct., 1914.

Kestrel.—From Dr. D'Ombrain.

Hieracidea berigora (No. 259).—Flinders Island, Nov., 1912.

Hieracidea occidentalis (No. 260).—Narrabri, Jan., 1918.

Trichoglossus swainsoni (No. 274).—Encounter Bay, Jan., 1921.

Calyptorhynchus leachi (No. 289).—Narrabri, Nov., 1916 (2); Dorrigo, Jan., 1918 (nil).

Eclectus macgillivrayi.—North Queensland (Dr. MacGillivray).

Platycercus flaviventris (No. 307).—Flinders Island, Nov., 1912.

Platycercus eximius (No. 311).—Belaringar, May, 1915; Dubbo, July, 1915 (2 nil); Kendall, Aug., 1918 (nil).

Psephotus haematonotus (No. 324).—Cowra, Sept., 1911 (nil); Coonamble, Aug., 1912.
Lathamus discolor (No. 332).—Flinders Island, Nov., 1912.
Eurystomus pacificus (No. 341).—Scone, Oct., 1917.
Halcyon macleayi (No. 347).—Stradbroke Island, Q'land, Sept., 1919.
Merops ornatus (No. 352).—Coonabarabran, Sept., 1914.
Eudynamis cyanocephala (No. 371).—Mummulgum, near Casino, Dec., 1916 (2).
Erythrodryas rosea (No. 396).—Hawkesbury River, June, 1912.
Monarcha carinata (No. 455).—Ourimbah, Nov., 1911.
Graucalus melanops (No. 457).—Upper Manilla, Sept., 1914; Tarcoon, Oct., 1914 (2 nil); Beltana, Aug., 1921 (nil).
Graucalus parvirostris (No. 457A).—Flinders Island, Nov., 1912 (2).
Graucalus mentalis (No. 459).—Coonabarabran, Sept., 1914.
Oreocincla lunulata (No. 488).—Bunya Mountains, Q'land, Oct., 1919; Kuitpo, S. Austr., May, 1921 (nil).
Chthonicola sagittata (No. 501).—The Oaks, June, 1914.
Acanthiza nana (No. 503).—The Oaks, June, 1914 (nil); Bunya Mountains, Q'land, Oct., 1919.
Acanthiza reguloides (No. 507).—The Oaks, June, 1914 (2).
Acanthiza chrysorrhoa (No. 508).—The Oaks, June, 1914; Dubbo, July, 1915 (nil); Scone, May, 1917 (nil); Beltana, Aug., 1921 (nil).
Acanthiza uropygialis (No. 509).—Dubbo, Sept., 1911 (2), and July, 1915 (2 nil); Beltana, Aug., 1921 (nil).
Acanthiza lineata (No. 511).—Mount Irvine, June, 1915 (nil); Uralla, June, 1915 (nil); Encounter Bay, Jan., 1921 (nil), and Jan., 1922 (mallophaga).
Artamus sordidus (No. 564).—Coonabarabran, Sept., 1914 (mallophaga, no mites); Hawkesbury River, Oct., 1912 (nil); Upper Manilla, Sept., 1914 (mites, no mallophaga).
Colluricincla harmonica (No. 566).—Hawkesbury River, June, 1912 (mallophaga, no mites); Coonabarabran, Sept., 1914 (no mallophaga, mites); Encounter Bay, Jan., 1922 (mallophaga and mites).
Struthidea cinerea (No. 576).—Coonabarabran, 1914 (mallophaga and mites); Belaringar, April, 1915 (nil); Gunnedah, 1914 (1 with mallophaga and mites, 1 with mites, 1 nil).
Corcorax melanorhamphus (No. 577).—Coonabarabran, 1914 (mallophaga, no mites); Belaringar, April, 1915 (numerous nits, one mallophaga); Tarcoon, Oct., 1914 (mallophaga); Gunnedah, 1914 (nil); Dubbo, July, 1915 (mallophaga, (?) two species, no mites).
Melithreptus lunulatus (No. 613).—Sydney, Nov., 1911; Hawkesbury River, June, 1912 (no mallophaga, mites); Abbotsford, Sydney, Nov., 1911 (Melithreptus, probably M. lunulatus); Sydney, April, 1912 (no mallophaga, mites); Kuitpo, S. Austr., May, 1921 (nil).
Melithreptus brevirostris (No. 619).—N.S. Wales; Scone, May, 1917; Encounter Bay, Jan., 1921 (nil).
Myzomela sanguineolenta (No. 622).—Sydney, Oct., 1919 (Dr. D'Ombrain); Kendall, Jan., 1919 (nil).
Ptilotis auricomis (No. 652).—Hawkesbury River, June, 1912.
Myzantha garrula (No. 672).—Belaringar, April, 1915 (2, 1 with mallophaga), and May, 1915 (nil); Gunnedah, 1914 (4 with mites and no mallophaga); Upper Manilla, Sept., 1914 (mallophaga and no mites); Cobar, Nov., 1911 (perhaps M. flavigula); Scone, May, 1917.

Myzantha flavigula (No. 674)—Belaringar, April, 1915 (mallophaga) and May, 1915 (nil); Tarcoon, Oct., 1915 (nil).

Anthochaera carunculata (No. 675).—Hawkesbury River, July, 1912 (4, mallophaga and mites in 1, mallophaga only in 3); Scone, May, 1917 (nil).

Philemon citreogularis (No. 685).—Cowra, Sept., 1911; Gular, Oct., 1911.

Ptilonorhynchus holosericeus (No. 718).—Bunya Mountains, Q'land, Oct., 1919.

Ailuroedus smithi (No. 720).—Mummulgum, near Casino, Dec., 1916.

Sericulus chrysocephalus (No. 726).—Bunya Mountains, Q'land, Oct., 1919; Zool. Gardens, Sydney, Nov., 1919.

Corvus coronoides (No. 732).—Cobar, Nov., 1911; Belaringar, June, 1915 (3, all with mallophaga and 1 with mites also); Coonabarabran, Sept., 1914 (mallophaga and mites); Upper Manilla, Sept., 1914 (mallophaga and mites); Tarcoon, Oct., 1914 (2, 1 mallophaga only, 1 nil).

Corvus cecilae (No. 733).—(?)Locality (Dr. MacGillivray).

Strepera graculina (No. 735).—Scone, May, 1917 (2, mallophaga on 1, nil on 1).

Strepera arguta (No 736).—Flinders Island, Nov., 1912.

Gymnorhina tibicen, (No. 747).—Cobar, Nov., 1911 (either G. tibicen or G. leuconota); Upper Manilla, Sept., 1914 (mallophaga and mites); Tarcoon, Oct., 1914 (nil).

Sturnus vulgaris (English Starling).—Wagga, Aug., 1914.

9. Ticks.

Eudyptula minor (No. 62).—Rockingham, W. Austr., Nov., 1906 Ornithodorus taljae *(Guérin-Méneville)?* (larvae) and Ixodes percavatus, *Neum.*, identified by Nuttall and Warburton; Flinders Island, Bass Straits, Nov., 1912; Encounter Bay, Feb., 1921 (mallophaga only).

Pitta strepitans (No. 377).—Bunya Mountains, Q'land, Oct., 1919, Ixodes holocyclus, *Neum.*, round head.

Petrochelidon ariel (No. 387).—Bumberry, N.S. Wales, Oct., 1916, Argas lagenoplastis, *Frogg.*, in nests.

Sericornis citreigularis (No. 518).—Bunya Mountains, Q'land, Oct., Ixodes holocyclus, *Neum.*, round head.

10. Mites.

Lobivanellus lobatus (No. 128).—See under Mallophaga.

Pachycephala gutturalis (No. 428).—Uralla, June, 1915 (nil); Encounter Bay, Jan., 1922 (mites on wings).

Orthonyx spinicaudus (No. 464).—Dorrigo, Jan., 1918 (2).

Cinclosoma punctatum (No. 466).—Encounter Bay, Jan., 1922 (on wings).

Pomatorhinus temporalis (No. 478).—Canowindra, 1915 (3, red mites on 1).

Origma rubricata (No. 500).—Sydney, April, 1912.

Malurus longicaudus (No. 529).—Flinders Island, Nov., 1912.

Malurus cyanotus (No. 535).—Beltana, Aug., 1921 (under wings).

Artamus sordidus (No. 564).—See under Mallophaga.

Colluricincla harmonica (No. 566).—See under Mallophaga.

Neositta chrysoptera (No. 583).—Hawkesbury River, June, 1912.

Climacteris scandens (picumna) (No. 592).—Narrabri, Feb., 1912.

Zosterops dorsalis (No. 599).—Sydney, Aug., 1911 (nil), June, 1912 (4, 2 nil), July, 1912 (12, 11 nil), Aug., 1912 (8 nil), and Dec., 1918 (1 nil).
Melithreptus lunulatus (No. 613).—See under Mallophaga.
Myzantha garrula (No. 672).—See under Mallophaga.
Anthochaera carunculata (No. 675).—See under Mallophaga.
Philemon citreogularis (No. 685).—Dubbo, Aug., 1917.
Zonaeginthus bellus (No. 693).—Flinders Island, Nov., 1912.
Aegintha temporalis (No. 703).—Gosford, May, 1915 (4 with mites); Encounter Bay, Jan., 1922, nil.
Corvus coronoides (No. 732).—See under Mallophaga.
Cracticus destructor (No. 745).—Tarcoon, Oct., 1914.
Gymnorhina tibicen (No. 747).—See under Mallophaga.
Sturnus vulgaris (English Starling).—Gunnedah, 1914 (2, young, 1 with mites).

II. No Ectozoa Detected.

Geopelia tranquilla (No. 27).—Coonamble, Aug., 1912.
Ochyphaps lophotes (No. 39).—Parachilna, Aug., 1921.
Ninox boobook (No. 263).—Flinders Island, Nov., 1912; Mannum, S. Austr., Nov., 1913.
Cacatua gymnopis (No. 293).—Beltana, Aug., 1921.
Cacatua roseicapilla (No. 295).—Belaringar, April, 1915.
Platycercus pennanti (No. 304).—Mount Irvine, June, 1915.
Psephotus haematogaster (No. 319).—Belaringar, May, 1915.
Euphema elegans (No. 327).—Encounter Bay, January, 1922.
Cuculus pallidus (No. 361).—Upper Manilla, Sept., 1914.
Cacomantis flabelliformis (No. 362).—N.S. Wales, Nov., 1911.
Microeca fascinans (No. 388).—Sydney, Nov., 1911.
Petroica phoenicea (No. 393).—Flinders Island, Nov., 1912.
Petroica goodenovii (No. 394).—Beltana, Aug., 1921.
Melanodryas bicolor (No. 397).—Encounter Bay, Jan., 1921.
Smicrornis brevirostris (No. 400).—Scone, May, 1917; Dubbo, Aug., 1917.
Gerygone fusca (No. 405).—Lisarow, May, 1915.
Pachycephala rufiventris (No. 430).—Kendall, Jan., 1919; Beltana, Aug., 1921.
Myiagra plumbea (No. 444).—Hawkesbury River, Oct., 1912.
Campephaga humeralis (No. 462).—Hawkesbury River, Oct., 1912.
Hylacola pyrrhopygia (No. 474).—Encounter Bay, Jan., 1921.
Hylacola cauta (No. 475).—Monarto South, May, 1921.
Cincloramphus cruralis (No. 484).—Near Broken Hill, April, 1917.
Ephthianura albifrons (No. 489).—Encounter Bay, Jan., 1921 (2).
Ephthianura tricolor (No. 490).—Parachilna, Aug., 1921.
Ephthianura aurifrons (No. 491).—Broken Hill, April, 1917; Parachilna, Aug., 1921.
Sericornis frontalis (No. 519).—Lisarow, May, 1915 (2).
Malurus cyaneus (No. 530).—Sydney, Nov., 1911; Kuitpo, S. Austr., May, 1921.
Malurus assimilis (No. 538).—Beltana, Aug., 1921.
Artamus superciliosus (No. 560).—Cowra, Sept., 1911.
Artamus melanops (No. 562A).—Gunnedah, 1914; Beltana, Aug., 1921.
Grallina picata (No. 575).—Cowra, Sept., 1911; Pennant Hills, Sydney, Dec., 1916 (D. Steel).
Aphelocephala leucopsis (No. 578).—Gular, Oct., 1911 (2); Yanco, Oct., 1912; Mount Lofty Ranges, Nov., 1920.
Pardalotus striatus (No. 603).—North of Renmark, Jan., 1921.

Pardalotus affinis (No. 605).—Flinders Island, Nov., 1912.
Pardalotus xanthopygius (No. 607).—Mannum, S.. Austr., Nov., 1913.
Glyciphila fulvifrons (No. 629).—French's Forest, near Sydney, June, 1915.
Ptilotis fusca (No. 643).—French's Forest, June, 1915; Dubbo, July, 1915.
Ptilotis sonora (No. 646).—Parachilna, Aug., 1921; Encounter Bay, Jan., 1922.
Ptilotis chrysops (No. 648).—Hawkesbury River, June, 1912, and Nov., 1914.
Ptilotis leucotis (No. 651).—Dubbo, Aug., 1917.
Ptilotis ornata (No. 656).—Monarto South, May, 1921.
Lichmera australasiana (No. 667).—Flinders Island, Nov., 1912.
Ptilotis leilavalensis (No. 661A).—Beltana, Aug., 1921.
Acanthogenys rufigularis (No. 679).—Narrabri, Nov., 1916.
Anthus australis (No. 687).—West Island, Encounter Bay, Jan., 1922.
Mirafra horsfieldi (No. 688).—Encounter Bay, Jan., 1922.
Turtur ferrago (introduced Dove).—Sydney, Mar., 1917.
Passer domesticus (Sparrow).—Sydney, June, 1917.

12. Haematozoa.

(a) HALTERIDIA IN THE RED CORPUSCLES.

Eudynamis cyanocephala (No. 371).—Mummulgum, near Casino, Dec., 1916 (halteridia in 2 with gametes in both).
Melithreptus brevirostris (No. 619).—Encounter Bay, Feb., 1921; Monarto South, Oct., 1920 (nil).
Ptilotis leilavalensis (No. 661A).—Beltana, Aug., 1921.
Acanthogenys rufigularis (No. 679).—Narrabri, Nov., 1916 (one seen, occupying both ends of the red cell and one side); Monarto South, Oct., 1920 (nil).
Tropidorhynchus corniculatus (No. 684).—Milson Island, Hawkesbury River, May, 1915 (with Leucocytozoon).

(b) TRYPANOSOMES IN THE BLOOD.

Pachycephala melaneura (No. 426).—Stradbroke Island, Q'land, Sept., 1919.
Entomyza cyanotis (No. 680).—Bumberry, Jan., 1916 (one degenerated trypanosome seen, with Leucocytozoon).

(c) LEUCOCYTOZOA IN THE BLOOD.

Entomyza cyanotis (No. 680).—Bumberry, Jan., 1916 (with trypanosomes).
Tropidorhynchus corniculatus (No. 684).—Milson Island, Hawkesbury River, May, 1915 (with Halteridium).
Ailuroedus smithi (No. 720).—Bunya Mountains, Q'land, Oct., 1919 (a few large spherical Leucocytozoa).

13. Haematozoa not Detected.

Geopelia humeralis (No. 26).—Stradbroke Island, Q'land, Sept., 1919.
Eudyptula minor (No. 62).—Encounter Bay, Feb., 1921.
Hieracidea occidentalis (No. 260).—Narrabri, Jan., 1918.

Calyptorhynchus leachi (No. 289).—Narrabri, Nov., 1916 (2); Dorrigo, Jan., 1918.

Cacatua gymnopis (No. 293).—Beltana, Aug., 1921.

Platycercus pennanti (No. 304).—Mount Wilson, June, 1915; Bunya Mountains, Q'land, Oct., 1919.

Platycercus eximius (No. 311).—Dubbo, July, 1915.

Eurystomus pacificus (No. 341).—Scone, Oct., 1917.

Cacomantis flabelliformis (No. 362).—Milson Island, Hawkesbury River, Jan., 1915 (young bird); Stradbroke Island, Q'land, Sept., 1919.

Petrochelidon nigricans (No. 386).—Stradbroke Island, Q'land, Sept., 1919.

Orthonyx spinicaudus (No. 464).—Dorrigo, Jan., 1918.

Oreocincla lunulata (No. 488).—Bunya Moutains, Q'land, Oct., 1919.

Chthonicola sagittata (No. 501).—Baan Baa, Jan., 1917.

Acanthiza uropygialis (No. 509).—Baan Baa, Jan., 1917, Dubbo, July, 1915.

Acanthiza lineata (No. 511).—Bunya Mountains, Q'land, Oct., 1919.

Acanthiza pusilla (No. 512).—Bunya Mountains, Q'land, Oct., 1919.

Sericornis frontalis (No. 519).—Canobolas, Oct., 1916 (2 birds); Mount Irvine, June, 1915.

Malurus cyanochlamys (No. 530A).—Bunya Mountains, Q'land, Oct., 1919.

Malurus melanocephalus (No. 542).—Mummulgum, near Casino, Dec., 1916.

Artamus leucogaster (No. 559).—Stradbroke Island, Q'land, Sept., 1919.

Colluricincla rufigaster (No. 573).—Stradbroke Island, Q'land. Sept., 1919.

Climacteris leucophaea (No. 593).—Bunya Mountains, Q'land, Oct., 1919.

Zosterops dorsalis (No. 599).—Bunya Mountains, Q'land, Oct., 1919.

Stigmatops ocularis (No. 639).—Stradbroke Island, Q'land, Sept., 1919.

Anthochaera carunculata (No. 675).—Scone, April, 1917.

Sericulus chrysocephalus (No. 726).—Mummulgum, Dec., 1916.

Corvus coronoides (No. 732).—Bumberry, Jan., 1916.

Corvus cecilae (No. 733).—Stradbroke Island, Q'land, Sept., 1919.

Strepera graculina (No. 735).—Scone, April, 1917 (2 birds).

Passer domesticus (Sparrow).—Sydney, June, 1917.

THE EXTERNAL CHARACTERS OF POUCH EMBRYOS OF MARSUPIALS.

NO. 4.—*PSEUDOCHIROPS DAHLI.*

By Frederic Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read June 8, 1922.]

Plate VI.

For all the pouch embryos of this interesting form I am indebted to the authorities of the Perth Museum. The animal was first described by Professor Collett in 1895. In 1915 it was placed by Matschie in the sub-genus *Pseudochirops,* when that author split up the large Genus *Pseudochirus* of Ogilby. *Pseudochirops dahli* and *P. archeri* are the only Australian members of the sub-genus, the other seven constituent species being confined to New Guinea. From the external characters of the pouch embryo it would appear to be a particularly interesting form, and one that is undergoing remodelling in response to the demands of a comparatively recent radiation.

Hair.—Hair is first visible in the 80 mm. stage, at which time the embryo is flesh coloured. The 50 mm. embryo shows no trace of body hair, though the specialized tactile vibriscae are present. When the embryo has reached 105 mm. the body is entirely clothed with short hair, the general colour of which is light brown. The skin of the embryo is free of pigment.

Hair Tracts.—The hair tracts are charted from male B, Perth Museum, the embryo, which is shown at pl. vi., being 105 mm. in total length. Upon the head are numerous definite hair fields arranged in a rather complicated manner (see fig. 1).

(A) Immediately behind the naked rhinarium a field of short hair shows a uniform forward direction; the free tips of the short hairs extend to the superior margin of the naked rhinarium, and to the upper margina of the narial slit.

(B) Behind this is an area extending backwards to the anterior angle of the eye, and laterally downwards to the mysticial region. In this field the hair is directed forwards and towards the mid-line, so that the areas of the two sides of the snout meet in the mid-line at a hair ridge. This field is also marked off by a definite ridge from the field immediately in front of it.

(C) Above and around the eye, the hair streams upwards and backwards so that it leaves a well-marked divergent parting above and in front of the orbit where the hair of

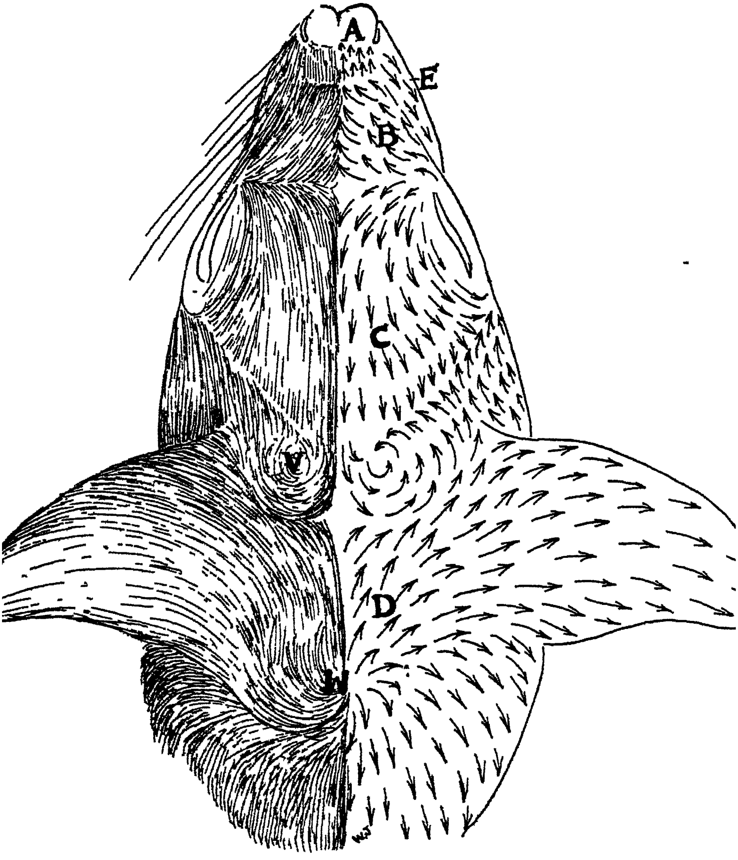

Fig. 1.
Hair tracts of the head (from Specimen Male B, Perth Museum, 105 mm).

field (C) streams backwards away from the forwardly-directed hair in field (B).

The area (C) meets its fellow of the opposite side in the mid-line of the head and ends behind at a convergent hair-line which runs roughly from the crown of the head to the

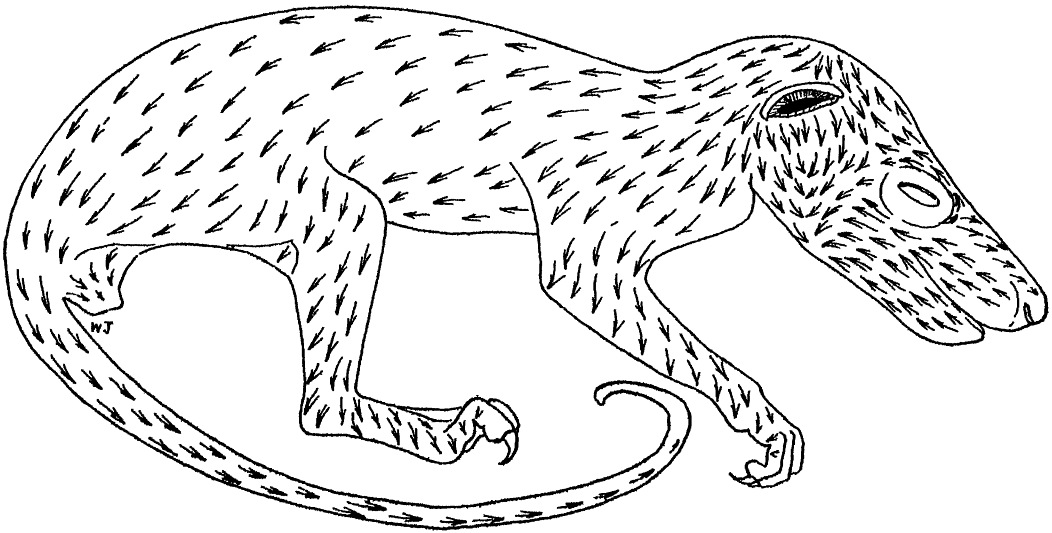

Fig 2.
Hair tracts (Specimen Male B, Perth Museum, 105 mm)
The auricle is represented as cut off close to the head.

posterior margin of the palpebral fissure. At the crown of the head a whorl (V in fig 1) is developed upon each side of the middle line at the upper end of this convergent line.

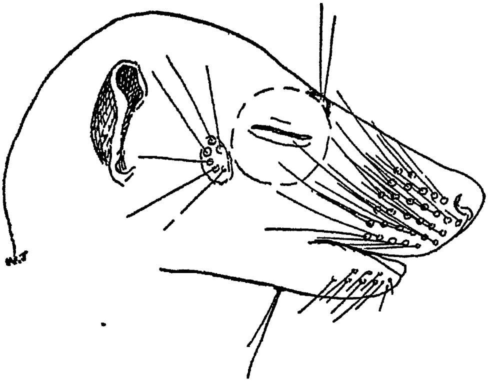

Fig. 3.
Facial vibriscae (from Specimen A, Perth Museum, 80 mm.).

The next tract (D) is a complex one, for radiating from a single mid-line whorl (W in fig. 1) situated upon the dorsal surface of the head opposite the margin of the ears, the hair streams in three different directions: (1) forwards and downwards, where it meets (C) at the convergent hair-line; (2) outwards to clothe the dorsal and posterior surface of

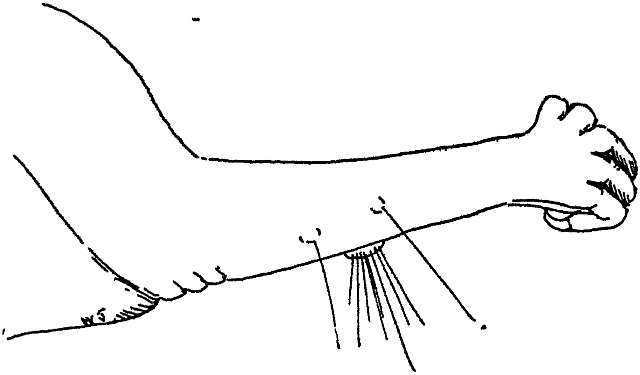

Fig. 4.
Brachial vibriscae (from Specimen Female A, Perth Museum, 80 mm.).

the ear; and (3) backwards and downwards into the general body stream.

Upon the side of the face the mysticial field, which starts at the lower narial margin and turns backwards below

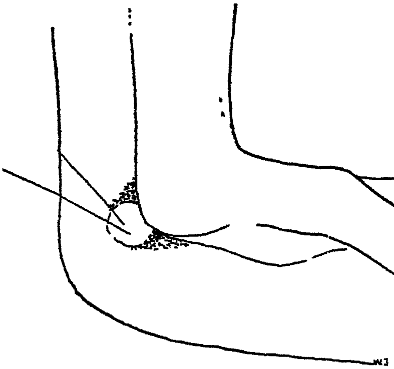

Fig. 5.
Calcaneal vibriscae (from Specimen Female A, Perth Museum, 80 mm.).

(A) and (B), becomes continuous with the sub-occular field. The hair in this tract (E) is directed backwards and slightly downwards. At the angle of the mouth it joins with

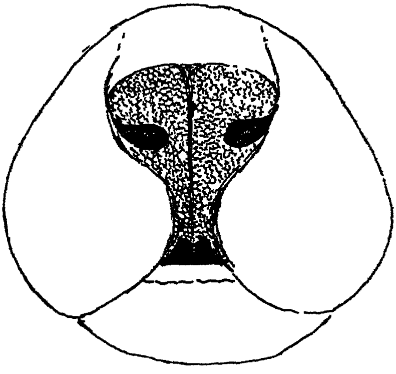

Fig. 6.
Rhinarium (from Specimen Female A, Perth Museum, 80 mm.).

the backwardly directed stream of the lower jaw. These combined backwardly-directed streams meet the pre-auricular part of the field (D) and continue the convergent hair-line, which, starting at the crown of the head, ran past the posterior angle of the eye to the lower jaw near its angle.

The hair tracts of the body and limbs need little description to supplement their diagrammatic representation in fig. 2.

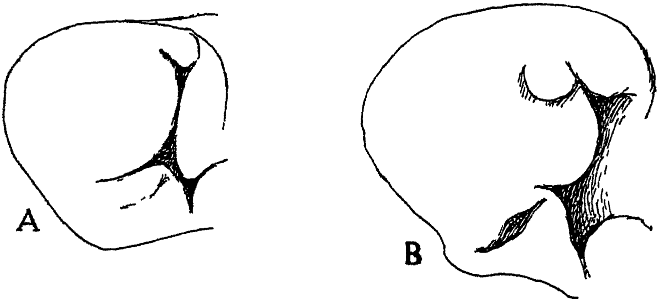

Fig. 7.
Form of the external ear.
A, 35 mm. stage. B, 50 mm. stage.

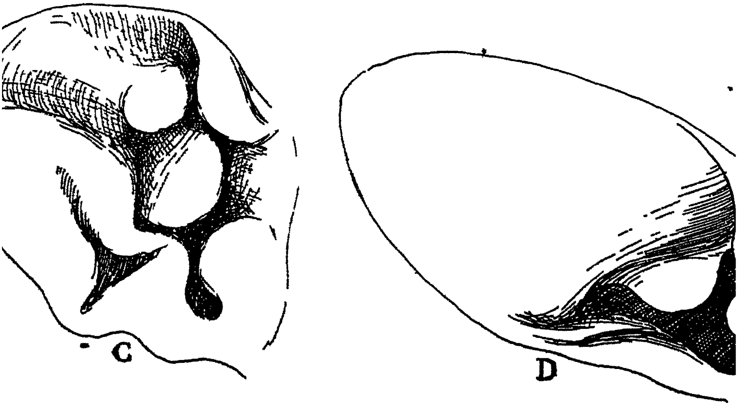

Fig. 8.

Form of the external ear.
C, 80 mm. stage. D, 105 mm. stage.

There are no hair reversals upon the body or limbs, and no whorls, crests, or partings are present. The main streamlines are caudad and ventrad on the body and ventrad and post-axial on the limbs.

Hair is continued to the ungual extremity of the phalanges of both manus and pes; the heels in the fully-haired embryo are almost wholly naked.

The hair when first present is so pale as to be practically colourless; when the embryo is fully haired the hair is of a very pale brown.

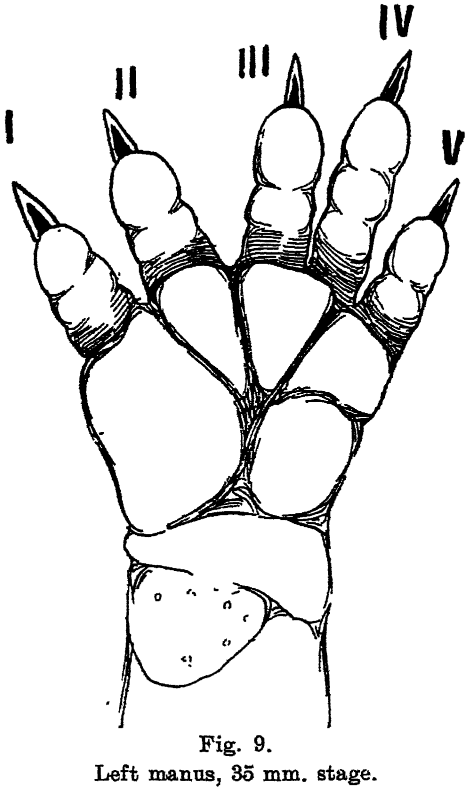

Fig. 9.
Left manus, 35 mm. stage.

Sensory Papillae and Vibriscae.—Sensory papillae are developed at the 35 mm. stage and vibriscae are present at 50 mm. The first papilla to appear is the ulnar-carpal.

Facial Vibriscae.—The mysticial set consists of 6 rows of papillae (in Collett's description 7), giving rise to 2, 5, 7, 6, 6, and 5 backwardly-directed, pale vibriscae, respectively. The supraorbital papilla is large, and gives origin to 2 vibriscae. The genal bears 6 long sensory hairs. The interramal is inconspicuous, with 2 pale hairs; and the submental consists of small papillae with rather trivial but early developed hairs (see fig. 3).

Brachial Vibriscae.—The ulnar-carpal papilla is large, and gives rise to a brush of half a dozen or so pale bristles.

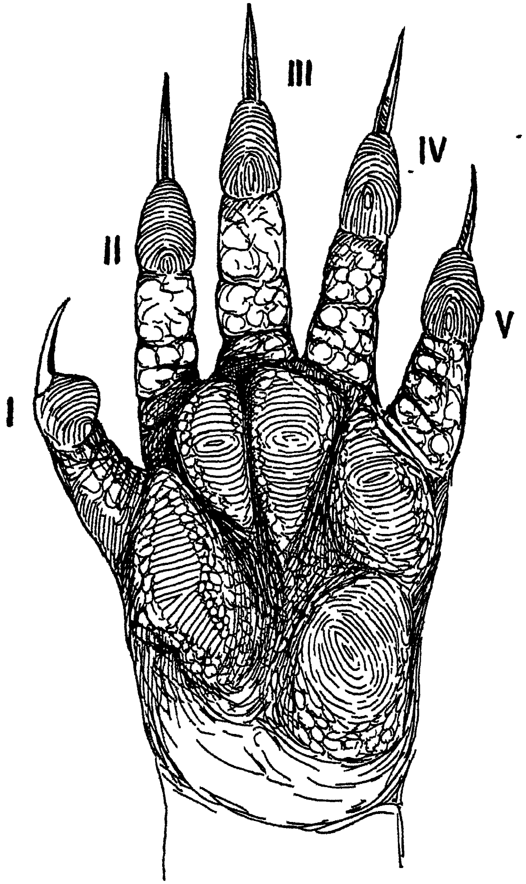

Fig. 10.
Left manus, 105 mm. stage.

The anconeal and the medial brachial give rise to a single hair each (see fig. 4).

Crural Vibriscae.—The crural papilla is well developed. Two stout tactile hairs arise from it, one of these bristles being, in all specimens, considerably longer than the other (see fig. 5).

The Rhinarium.—The rhinarium is roughly triangular in shape and distinctly grooved in the middle line. The surface is finely granular. The narial slits are bounded above entirely by naked skin, but their lower margins are pubescent behind. The infranarial portion of the rhinarium runs to the upper lip, forming a very definite portion of its medial area. (see fig. 6).

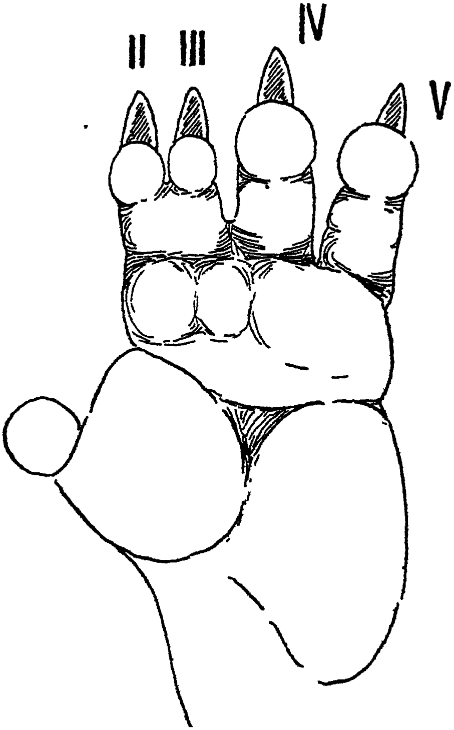

Fig. 11.
Left pes, 35 mm. stage.

The External Ear (see figs. 7 and 8).—In all stages which I have examined the auricle has been folded backwards. This is true of the 35 mm. embryo. The whole process of the development of the pinna may be described as a progressive simplification. Two well processi antihelicis appear, but only one persists as a meatal operculum. A well-marked bursa in the 80 mm. embryo becomes reduced to an insignificant depression in the 105 mm. stage. Of the tragus and antitragus, the tragus alone persists in any degree of finished development.

The Manus (see figs. 9 and 10).—The digital formula of the haired embryo is 3>4>2>5>1. In the earlier stages the 4th digit is longer than the 3rd. In the 80 mm. embryo there is a definite tendency for the digits 1 and 2 to stand

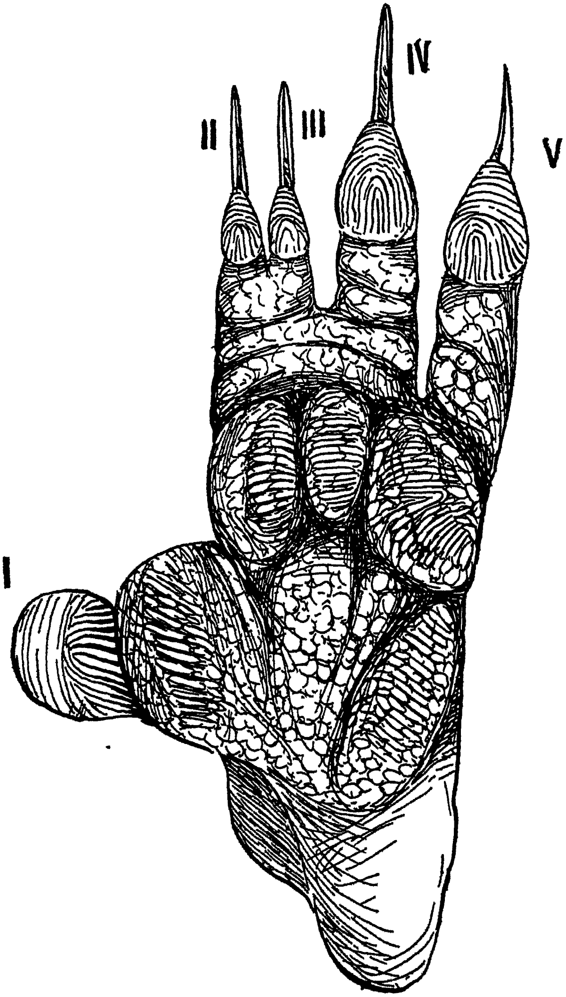

Fig. 12.
Left pes, 105 mm. stage.

in opposition to digits 3, 4, and 5; but by the 105 mm. stage this dual division of the manus has ceased to be at all well marked. Herein lies the great interest of the manus of this form. Apical pads are present on all digits and are striated. Interdigital pads are striated and are 3 in number, interdigital pad 1 being fused with the thenar pad.

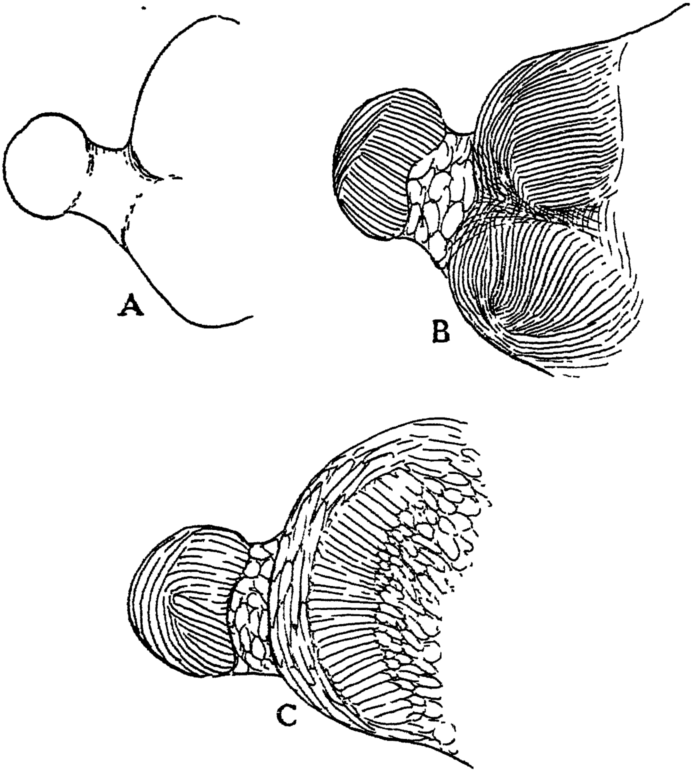

Fig. 13.

Three stages in the development of the pad at the base of the first pedal or digit.

A, 50 mm. B, 80 mm. C, 105 mm.

The Pes (see figs. 11, 12, 13).—The digital formula is $4>5>\overset{\frown}{2, 3}>1$; the syndactylous toilet digits being relatively far longer in the early stages. Apical pads are present and striated. Interdigital pads striated, but the striations are somewhat ill defined in older embryos. The point of outstanding interest is the fusion of interdigital pad 1 with the thenar pad, and the progressive diminution of the striations. Between the 80 mm. and the 105 mm. stages considerable readjustment takes place in the disposition of the sole in the region of the base of the first pedal digit (see (B) and (C) in fig. 13). Professor Collett has described in an embryo “about 100 mm., from snout to vent” 2 pads at the base of the big toe, but gives no description of the pads in the adult. This change is presumably to be correlated with the loss of opposibility of digits 1 and 2 to digits 3, 4, and 5 in the manus. It would seem that the animal had somewhat fallen from the arboreal standards of its immediate stock. The diagnosis made from the conditions of the hands and feet is borne out by Professor Collett's account of its habits: “During the day time it hides amongst the colossal boulders, and leaves the rocks only at night, when it ascends the trees in search of food” (P.Z.S., 1897, p. 332).

External Genitalia.—The pouch is normal. The opening directed cephelad, and 4 mammary areas are present.

DESCRIPTION OF PLATE VI.

Pseudochirops dahli.

Pouch young photographed against a background of $\frac{1}{12}$-in. squares. Specimen Male B, Perth Museum, 105 mm.

THE TERTIARY BROWN-COAL BEARING BEDS OF MOORLANDS.

By Sir Douglas Mawson, D.Sc., B.E., and Frederick Chapman, A.L.S., F.R.M.S.

[Read June 8, 1922.]

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        Section B.—Light-grey and dark-grey Clayey Marls and Calcareous Muds.
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I. INTRODUCTION.

The occurrence of brown coal in Tertiary strata in the vicinity of Moorlands, a railway station on the Pinnaroo line about 87 miles from Adelaide, has led to very considerable mining activity thereabouts during the past two and a half years. As a result, much valuable geological information has been collected in an area where otherwise no geological section of the beds would be available.

We are particularly indebted to Mr. A. C. Broughton, the representative on the field of the principal mining company, for assistance in procuring data and material amplifying such as was secured on our own visits, which date back to the inception of the present mining enterprise. The Government Geologist has also favoured us with information required relating to the Government bores.

Though the main bulk of these notes were prepared more than two years ago, publication has been delayed in case important additional information relating to the beds should accrue as a result of mining development. In the meantime much has been made public in the Mining Reviews⑴ of the Department of Mines under reports by the Government Geologist, Mr. L. K. Ward; the Chief Inspector of Mines, Mr L. J. Winton; and the Engineer for Boring, Mr. C. F. Duffield. A short note has also been contributed by Mr. A. C. Broughton.⑵

The scope of this present paper is accordingly restricted to generalized notes upon the strata, more particularly a correlation with the Tertiary beds of other localities.

II. GENERAL PHYSIOGRAPHIC AND GEOLOGICAL FEATURES.

Moorlands is situated on a nearly level mallee-covered plain which extends from the Murray River (some 10 miles to the west) eastward into Victoria. Over all this area undulations of the surface are rarely conspicuous. Perhaps the most noteworthy of such is the long, low rise known as Marmon Jabuk Range, which trends in a general N.N.E. and S.S.W. direction across the country just to the north of the Moorlands coal field. Such rises are often composed of flexed Tertiary beds, but, at other times, much more ancient rocks come to the surface in these more highly elevated portions. The latter are frequently slaty beds not unlike certain of the "Adelaide Series," and probably of late pre-Cambrian age.⑶ At times more highly altered sedimentary rocks appear; for example, a strongly developed chlorite schist was entered in a well sunk about one mile south-east of Moorlands railway station. Ancient igneous rocks are, probably, not uncommon underlying the Murray mallee lands, as evidenced by the outcrops of pink granite at Mannum, at Murray Bridge, and to the south of Coonalpyn; also, the appearance of a broad intrusive sheet of gabbroic rock, now much modified by age, exposed in the railway cutting, on the line to Moorlands, about two miles beyond Tailem Bend.

But, though there is unquestionably a considerable diversity in the underlying strata, the surface features of these mallee plains, as a rule, give little indication thereof, for there is developed everywhere at the surface a hard travertine formation which varies from a few inches to a few feet in thickness. It is thickest where it overlies Tertiary strata and thinner where the more ancient rocks underlie it.

⑴ See Mining Review, Nos. 13, p. 21; 32, pp. 32-38; 33, pp. 66-78; 34, pp. 31, 32, 34-39, 43-50; 35, pp. 25, 26, 28-42, 47-55.

⑵ "Notes on the Geology of the Moorlands (South Australia) Brown Coal Deposits," by A. C. Broughton, Trans. Roy. Soc. S. Austr., vol. xlv., 1921, pp. 248-253.

⑶ *Vide* Paper read by T. W. E. David, Trans. Roy. Soc. S. Austr., vol. xlvi., Nov., 1921.

Where one has to cross this country in a vehicle, the travertine, outcropping in knobby and platy masses, is, for the most part, developed uncomfortably close to the surface, but in depressed areas it is usually covered by a thin mantle of sand or sandy soil. Occasionally, superficial sand is heaped up into low dunes, which aid to modify the monotonous level of the country.

Even in the areas occupied by them, it is a rare thing to locate the Tertiary beds definitely by the discovery of fossil remains at the surfaces, though some of the larger molluscan remains have been found amongst the surface travertine in specially favoured spots. Bores put down in search of brown coal are gradually furnishing definite data as to the distribution and details of deposition of these beds; but so far, beyond the fact that some part of the trans-Murray mallee country is underlain by Tertiary formations and some is not, little absolutely definite is known.

The probability is that only in minor areas does the ancient primary rock come to the surface. Elsewhere fossiliferous Tertiary beds, in greater or less thickness, either horizontal or but slightly inclined, are to be expected as the uppermost formation, but owing to the semi-arid climate are masked at the surface by the development of a dense superficial layer of travertine or aeolian sand formation.

The steep cliff-like banks of the lower Murray river, which latter approaches within 10 miles of Moorlands, furnish good geological sections through marine Miocene (Janjukian) beds which have been long explored. Patches of lower Pliocene (Kalimnan) limestone are also dispersed in this region, above the Janjukian, but are less regular than the latter.

To the east of the river, in the vicinity of Tailem Bend, these beds thin out very quickly, and within a few miles of the river the older formation comes to the surface over considerable areas. In this neighbourhood only scattered shallow pockets of the Tertiary, principally Kalimnan, are met with. This condition persists eastwards until Moorlands station is closely approached, when a decided and continuous low dip to the east carries the pre-Tertiary rocks downwards, so that an ever-increasing thickening of the Tertiary beds is met with as the Victorian border is approached. This state of affairs is illustrated by the data from various bores quoted by Mr. L. K. Ward.(4) Whereas "bed rock" (pre-Tertiary) is encountered at depths ranging between 50 ft. and 100 ft. in most of the areas where mining activity is now proceeding at Moorlands, a bore sunk at a point 40 miles to the east penetrated 852 ft. of Tertiary strata before meeting the older bed rock.

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(4) Min. Rev., No. 33, pp. 72-74.

Recent mining exploitation has shown that the brown coal seams are developed at or near the bottom of the Tertiary formation. As a consequence of the dip to the east, the brown coal formation comes to the surface, or nearly approaches it, in the Moorlands area. It is this fact that has led commercial exploitation to especially favour this particular locality, for open-cut mining is thus made possible, as opposed to the more expensive method of winning the coal by deep mining, entailing additional costs in labour, pumping, and timbering.

In connection with mining exploration, bores are now being sunk at intervals of 300 yards, and even closer, in places. This close boring is steadily accumulating a fund of information invaluable for discussion of the contour of the surface upon which the Tertiary strata was laid down. Thus, also, will much light be shed upon the question of erosion intervals, if such do actually exist between the beds of the Tertiary strata. But until all the bores can be referred to the same datum level, which has not so far been done, final statements in regard to the above must be deferred.

In Mr. Broughton's paper(5) reference is made to one line of bores which he had related to the same datum level by means of a dumpy-level traverse. As a result, he shows that the floor of the Tertiary formation is slightly undulating and the coal beds occupy the depressions in this old land surface of low relief. On this evidence it is assumed that the shallow basins containing coal are isolated by rises in the floor of ancient slaty rocks.

These depressed basins may have been ponded areas in the coal-forming period, where plant life thrived and was preserved in sodden beds. Subsequent marine sedimentation overlapped the lignite-filled basins and extended as a continuous sheet over much of the former old land surface.

The very unequal thicknesses of brown coal met with in the various bores is accounted for, at least partly, by such an original accumulation in basins. But it yet remains to be shown to what extent irregularities in the coal beds are due to wash-outs of the nature of erosion by contemporaneous streams of the coal-forming period, which tracks would be afterwards obliterated by silts rendered highly carbonaceous from ligneous matter transported from erosion areas elsewhere. This and the question of a general erosion interval at the upper limit of the lignite beds, with its bearing also upon the extent and distribution of the residual lignite are matters to be settled when the boring operations are completed.

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(5) *Loc. cit.*

III. The Tertiary Strata at Moorlands.

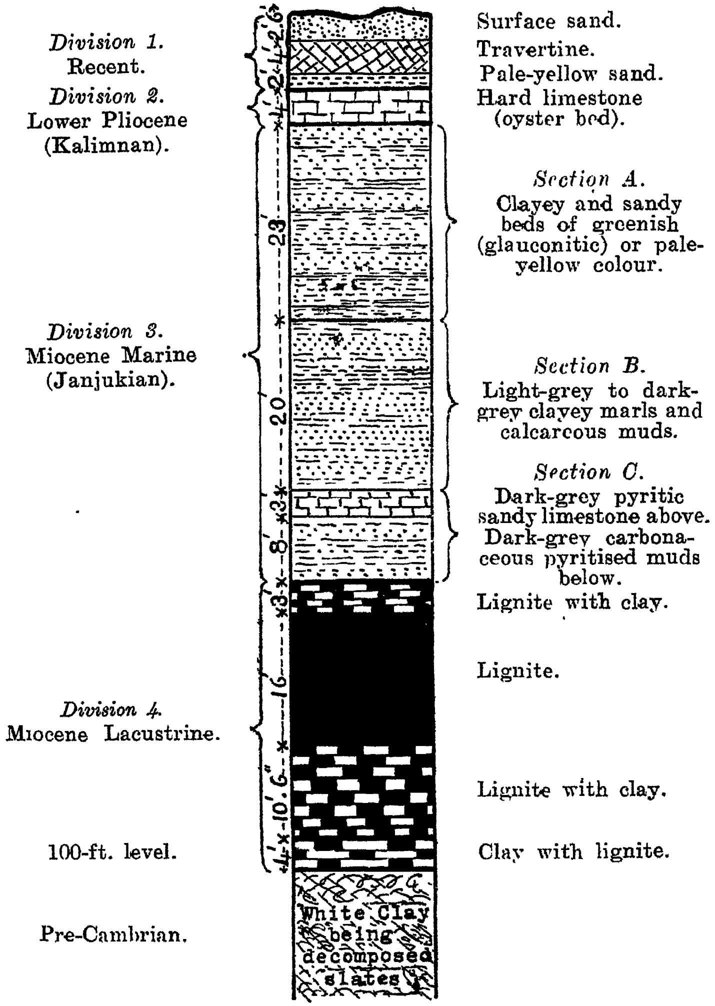

Fig. 1.

The geological section, set forth herewith, represents the Tertiary strata existing in the vicinity of the main shaft sunk by the Murray Coal and Oil Co., which is at the same time the vicinity of Government Bore 25. It is the particular locality where most of our detailed observations were made. In order to better illustrate the average nature of the beds, a slight generalization has been assumed.

In the following descriptions, the major formations are taken in descending order from the surface.

Division 1.

RECENT SURFACE FORMATION.

Travertine, with more or less blown sand, forms a surface layer. The travertine is the usual surface form developed under the conditions of a semi-arid climate. In some parts of the field, the travertine sits directly upon the *Ostrea* limestone, and is little more than an addition to and modification of it. Elsewhere, sandy beds intervene which may or may not belong to the marine series below.

Division 2.

A KALIMNAN (LOWER PLIOCENE) OYSTER BED.

This is a hard marine limestone, usually buff-coloured. This rock is what may be termed a "ragstone," or roughly fracturing limestone, filled with oyster shells and pectens. It would appear from the results of borings that this bed is not continuous over the field. In many cases, however, it is undoubtedly included with the surface travertine in the one entry. The fossils determined from this horizon are:—

Pelecypoda—*Ostrea arenicola*, Tate, a smooth upper valve; *O. sturtiana*, Tate, probably the commonest fossil in this bed; *Pecten antiaustralis*, Tate, rare; *P. palmipes*, Tate, a fragment only; *Spondylus arenicola*, Tate, a restricted Aldingan species, rare.

Pisces—*Isurus hastalis*, Agassiz, sp. (tooth). This fossil is rather worn, but the outline leaves no doubt of its identity. A common Victorian Kalimnan fossil.

Embedded in this limestone small pebbles of white quartz and other rocks are occasionally met with. Of the latter the following were collected:—A water-worn pebble, 3 in. in length, of a rock resembling a mica granulite; several chips of slate up to 2 in. in length; and two pieces of basalt, one water-worn, the other partly faceted.

The latter basalt specimen measures about 4 in. by 2 in. It is a grey rock with open steam holes, the vesicles being drawn out by flow. In microscopic section, laths of labradorite felspar are noted to be the dominant feature. A flow arrangement of the felspars around the steam holes is evident. A large corroded fragment of plagioclase exhibiting polysynthetic twinning is also to be seen. A small amount of interstitial pyroxene is still visible. A considerable quantity of secondary serpentine is present and appears to be chiefly after olivine. Magnetite is present in moderate quantity, and also leucoxene. Traces of limonite and haematite are also present. This rock is not similar to any specimens of the Mount Gambier basalt which we have at hand for comparison, but in general character it is like some of the Melbourne basalts. The question that arises is from what locality and by what means did it become transported to its present situation?

Division 3.

JANJUKIAN (MIOCENE) MARINE BEDS.

Section A.

GREEN AND YELLOW CLAYS AND SANDS.

These are soft clayey and sandy beds, often notably calcareous, of greenish or buff colour. Yellowish and reddish mottlings and streaks may appear where these beds rise above ground water level, thus exposing the iron content to oxidising influences.

In some portions of the field borings have revealed strata in this section of the beds of great uniformity. In such cases a general buff colour is assumed. The greenish tint due to glauconite granules, which is an outstanding feature in other areas, is, in these situations, largely suppressed. In all cases, however, at least a little glauconite can be detected, on close examination. The buff-coloured silt forming the bulk of such beds is exceedingly fine-grained and of low specific gravity. The average grain size amongst the observable discrete particles in one of the finer bands proved to be 1/100 of a millimetre diameter. The coarser particles are well rounded except for very minute flecks of mica. The sand grains of the coarser beds of this series are unusually rounded and polished. In fact, a large part of these buff-coloured sediments is loessial in character. Such beds are particularly well represented in a bore at the cross roads, some two miles north of Moorlands station. The buff-coloured component of this sediment possibly originated as wind-blown dust from the interior of the continent, picked up and transported by the ancestral Murray-Darling River system. Judging from the highly glauconitic character of some of the beds, such were probably laid down in current-disturbed waters at a considerable depth.

Fossils are reasonably common only in the more highly glauconitic portions of this section. One such bed of a bright apple-green colour and of a calcareous nature was examined in detail for fossils. Polyzoa were found to be comparatively numerous and rotaline foraminifera not uncommon. Besides these there are occasional Brachiopods, Bivalves, joints of Alcyonarians, and ossicles and spines of Echinoderms.

A similar bed was struck in several of the Victorian mallee bores, where it was seen to be a bed of glauconitic and shelly sand and glauconitic chert.

A small series of fossils selected from a highly glauconitic bed of this division yielded the following:—

Foraminifera—*Truncatulina ungeriana*, d'Orb, sp. Fairly abundant.

Anthozoa—*Mopsea tenisoni*, Chapman. The smaller and slenderer joints of this coral are very abundant in the washings.

Echinodermata—Cidaroid spines, various; (?) *Antedon*, ossicle.

Polyzoa—*Cellaria*, sp.; *Adeona obliqua*, MacGillivray; *Porina gracilis*, Milne-Edwards, sp.; *Steganoporella patula*, Waters, sp.; *Cellepora gambierensis*, Busk; *Retepora permunita*, MacGillivray.

Brachiopoda—*Terebratulina catinuliniformis*, Tate; *Magasella woodsiana*, Tate.

Pelecypoda—*Pecten foulcheri*, T. Woods (a fragment).

Pisces—The following fish teeth were collected on the field and handed to the authors, it being understood that all were obtained from *Division 2* (the Miocene) of the section, and principally, if not entirely, from *Section A*. They are, in nearly all cases, much rolled and often imperfect. The determined species are:—

Odontaspis elegans, Agassiz, sp.—This widely distributed species is here quite abundant, being represented by about a dozen specimens. It is more commonly met with in the European Miocene and Pliocene than in Australia, and we have never before seen so many specimens of this form from one locality. It occurs in the Eocene and Lower Miocene of New Zealand, and in the Miocene and Lower Pliocene of Victoria.

Odontaspis incurva, Davis, sp.—This species is here represented by one specimen, nearly perfect, but for the left side of the base being missing. It is fairly common in the Miocene and Lower Pliocene of Victoria, and it has a much more extensive range in New Zealand, where it begins its history in the Upper Cretaceous (Danian) and ranges up to the Lower Miocene.

Odontaspis exigua, Davis.—This species is here represented by several examples. It is quite a new record for the Australian Tertiary deposits, as hitherto it has only been found in the New Zealand Lower Miocene of the Trelissick

Basin. The widely expanded base, relatively small size, and the short stout fang are distinguishing characters.

Odontaspis attenuata, Davis, sp.—Two imperfect examples are referred to the above species. It was recorded from the Oamaru Series of New Zealand. In Victoria it is found in the Miocene, and is of the same age in South Australia (Aldingan Series). It also occurs in the Lower Pliocene (Kalimnan) at Beaumaris, Port Philip.

Section B.

LIGHT-GREY AND DARK-GREY CLAYS.

These underlie the greenish and yellowish beds of the previous section. Faint bluish and chocolate colours sometimes appear. Sandy beds are not uncommon. These beds are fairly rich in calcium carbonate. Pyrites may enter in noticeable quantity at the base of this section. The predominating dark colour is due to carbonaceous matter, and is doubtless derived from beds of the underlying lignite where exposed in other areas undergoing erosion at the time of deposition of these clays.

Apart from the colouration due to carbonaceous matter, the beds of this section are very similar to the previous, and appear to be merely a continuation downwards of the same general type of sedimentation. Small marine fossils, principally gasteropods, are sparsely distributed in this section.

Section C.

MARINE LIMESTONE AND CARBONACEOUS MUDS, USUALLY PYRITISED.

This section immediately overlies the lignite series. It is never very thick. A hard dark-grey or, less frequently, light-yellow sandy limestone, full of marine fossil remains, usually limits it above and rests upon a dark sandy mud full of molluscan and other remains. Both the limestone and the mud are usually highly pyritised. At its base it often shows distinct brecciation, including fragments of slate. So that in all probability there was in progress in the vicinity, at the time of the accumulation of this bed, a great deal of erosion. The black carbonaceous and pyritous condition of the sediments points to material worn down from the previously formed lignitic bed.

It is without doubt equivalent to Tate's horizons(6) in the Croydon Bore at 1,376 ft. ("Bituminous clay and black sand; *Turritella aldingae*"), and 1,681 ft. ("Bituminous shale;

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(6) Trans. Roy. Soc. S. Austr., vol. xxii., 1898, p. 195.

casts of gasteropods in chalcedony, calcite and iron pyrites, some shell matter; *Turritella aldingae, Mesalia stylacris, Fibularia gregata, Cellepora*").

Examined as to its nature, the following details are observable:—

When moist this bed is somewhat sticky in texture, but easily washes down, on account of the large proportion of fine quartz sand which it contains.

Fine Washings.—These consist largely of quartz grains, sub-angular to rounded, with usually a very high polish. They were undoubtedly of aeolian origin and carried into the marine deposit either by estuarine river flows or high winds, but most probably through the former. The quartz grains measure about ·4 to 1 mm. in diameter. Admixed with the quartz grains are numerous granules of pyrites and fragments of polyzoa and calcareous molluscan shells; some of the shell fragments show attached crystals of iron pyrites.

Coarser Washings.—About one-sixth of the material remains as coarse washings and contains by far the larger number of fossils. These are more or less fragmentary, or often partially pyritised. Some of the smooth, rounded, white, quartz pebbles are beautifully coated by a superficial deposit of brassy pyrites laid on in electroplate fashion.

The fossils determined from this horizon are:—

Anthozoa—*Mopsea tenisoni*, Chapman; *M. hamiltoni*, Thomson, sp.

Echinodermata—A cidaroid spine, cf. *Leiocidaris*.

Polyzoa—*Cellepora gambierensis* Busk; *Adeona obliqua*, MacGillivray; *Porina gracilis*, Milne-Edwards, sp.

Brachiopoda—*Terebratula tateana*, T. Woods.

Pelecypoda—*Limopsis insolita*, Sowerby, sp.; *Arca (Plagiarca) cainozoica*, Tate, sp.; *A. (Barbatia)*, sp.; *Crassatellites communis*, Tate, sp.; *Cardita latissima*, Tate; *C. delicatula*, Tate; *Cardium monilitectum*, Tate; *Corbula pyxidata*, Tate; *C. ephamilla*, Tate.

Gasteropoda—*Collonia parvula*, Tate; *Euspira effusa*, Tate; *Turritella aldingae*, Tate; *T. tristira*, Tate; *T. platyspira*, T. Woods; *Diala*, sp.; *Letorium oligostirum*, Tate, sp.; *Marginella*, cf. *strombiformis*, T. Woods; *Scaphella pagodoides*, Tate, sp.; *S. pueblensis*, Pritchard, sp.; *Ancilla ligata*, Tate, sp.; *Turris*, sp.; *Actaeon*, cf. *subscalatus*, Cossmann.

Pisces—Fish otolith (Teleostean).

Division 4.

JANJUKIAN LACUSTRINE, CARBONACEOUS BEDS WITH LIGNITE.

These are fresh water lacustrine beds of very variable thickness which rest, more or less horizontally, upon the upturned edges of steeply inclined slates and other strata of Lower Cambrian or earlier age, and are overlain by the Janjukian marine beds. There appears to be some evidence of erosion of the upper limits of the ligneous series, but the extent of such will be better defined as exploration of the field proceeds.

It is evident, however, that the age of the fresh water lignite bearing beds is either Miocene or pre-Miocene. It is most reasonable to regard these beds as having formed contemporaneously with either one or other of the strongly developed Tertiary lignites of the adjacent State, Victoria. Referring to these latter occurrences, the Altona lignite series is intercalated with typical marine Oligocene (Balcombian) fossil bands. But the Morwell beds, so far as can be judged, occupy a former lacustrine or coastal swamp area, of which the hinterland river deposits of the Miocene Dargo High Plains form a part. Judging from the palaeogeography of the region therefore, the Morwell lignite is Miocene in age The reference of the carbonaceous lacustrine beds at Moorlands to the Morwell (Miocene) period is indicated by the fact that they appear to be comparable with a similar formation, underlying the polyzoal rock in the mallee, and which, besides containing lignite, includes typical Janjukian marine shells, *Trigonia lamarcki*, found occurring at the top of the Janjukian, and the foraminifer, *Cyclammina complanata*, Chapman, the latter being found at the base of the Janjukian at Anglesea.

Ligneous beds of a character similar to these at Moorlands are now being actively explored at three other localities in South Australia, namely, at Clinton,(7) on the west side of Gulf St. Vincent, almost at its northern extremity; at Hope Valley,(8) one of the northern suburban areas of Adelaide; and at Noarlunga,(9) 23 miles south of Adelaide, adjacent to Gulf St. Vincent. Furthermore, similar beds were encountered in a Government bore put down at Bower,(10) 20 miles west of Morgan, several years ago. There is also other evidence from boring operations in South Australia, indicating that prior to the period of formation of the Miocene marine beds there was a great and widespread development of Tertiary

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(7) *Vide* Dept. of Mines, S. Austr.; Min. Rev., Nos. 34, pp 29-31, 40, 51; 35, pp. 26, 27, 43-46, 55-56.

(8) Min. Rev., Nos. 14, p. 10; 20, pp. 19, 40, 41; 33, pp. 25-37; 34, pp. 27-29, 33, 41, 42; 35, pp. 13-15.

(9) Min. Rev., No. 33, pp. 78, 79.

(10) Min. Rev., Nos. 20, p. 11; 28, pp. 26-28; 29, p. 23.

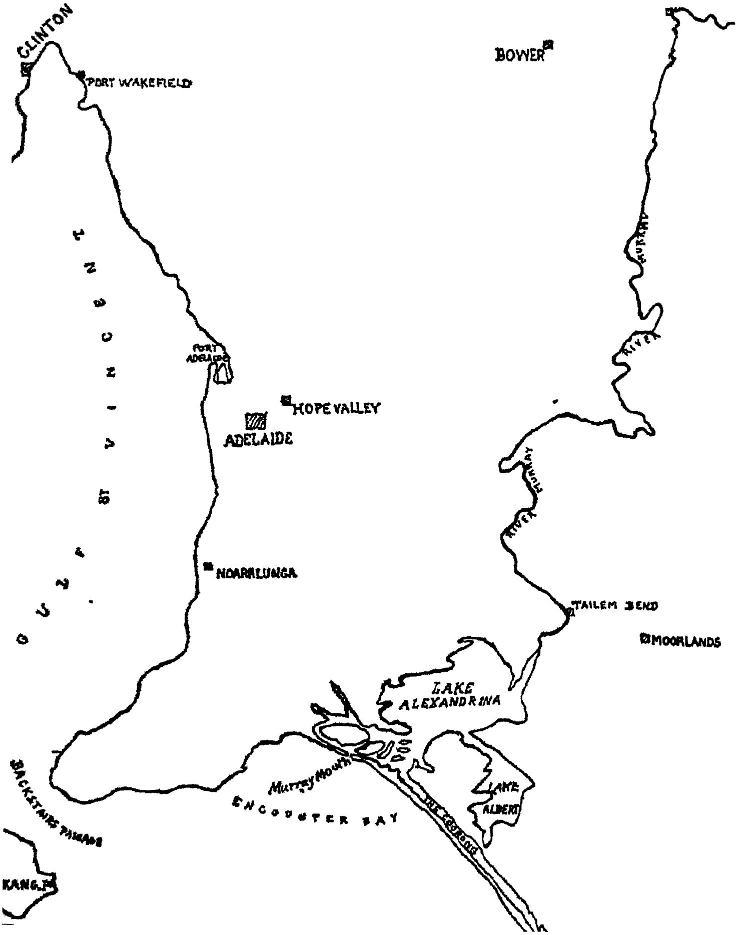

Fig 2.
Map illustrating South Australian Brown Coal Occurrences.

fresh water ligneous strata This fortunate circumstance has bequeathed to the present day large reserves of brown coal.

The South Australian areas where lignite beds have been proved belong to one or other of two main regions of Tertiary sedimentation. Of these, one is Gulf St. Vincent and its borderlands; to this the Clinton, Paradise, and Noarlunga occurrences are to be referred. The other is the great Murray Gulf, so marked a feature of Tertiary times in Australia, when a shallow sea extended all over the south-east lands of South Australia, part of Victoria, and even reaching well into New South Wales territory. Bower and Moorlands belong here. The published results of the Government bores indicate that the lignite beds of the Gulf St. Vincent area are embedded in, and entombed beneath, strata of a more sandy nature than is the case on the Murray side, where very fine clayey and calcareous silts are a greater feature. This is no doubt attributable to muddy waters delivered to the latter area by the great ancestor of the present Murray-Darling system.

In this connection there is some evidence indicating that, in all probability, the brown coal of the Gulf St. Vincent region may reach a greater degree of freedom from ash than that influenced by the muddy waters of the ancestral Murray. So far as at present explored, this is the case, as can be noted by a comparison of the seams at Moorlands with those at Clinton. The Mines Department Records give composite analyses(11) of all lignite beds met in all bores to date, respectively, in each of thes fields as follows:—

	Moorlands.	Clinton.
Moisture at 105° C. ...	51·41	51·47
Volatile matter ...	21·38	24·29
Fixed carbon	13·82	15·16
Ash	13·39	9·08
	100·00	100·00
Sulphur content .	2·66	2·01
Average moisture after air-drying	15·74	16·94

In arriving at these figures the Government Geologist, Mr. L. K. Ward, differentiates the carbonaceous beds as follows:—

"Lignite" is such as contains not less than 24 per cent. of ash.

"Lignite with clay" is the designation for beds containing between 24 and 50 per cent. ash.

"Clay with lignite" distinguishes beds containing over 50 per cent. ash.

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(11) Includes Bores 1 to 34, at Moorlands; and 1 to 4, at Clinton.

Though the above figures represent the average case, so far as exploration has yet proceeded, seams are met with of much better quality than the average here stated. For instance, at Moorlands the better quality lignite is illustrated in Bores 23, 24, and 31 by seams, respectively, 13 ft., 18 ft., and 16 ft. in thickness, averaging only about 7 per cent. ash. At Clinton, in Bore 1, a band of lignite, 15 ft. in thickness, containing less than 6 per cent. ash, is recorded; and in Bore 2 there is a 15-ft. seam with 7·3 per cent. ash.

The ultimate relative merits of the two fields, from an economic standpoint, depend upon factors far more important than slight differences in composition. The shallow depth of the formation, the more water-tight nature of the strata, the comparative freedom from serious quantities of groundwater, are all factors which favour the Moorlands area. On the other hand, convenience in geographic situation for marketing the fuel is favourable to the Gulf St Vincent localities.

It is probable that, in the aggregate, great quantities of brown coal will be proved, eventually, at the base of the Tertiary formations in South Australia. This is most reassuring from an economic standpoint, for the mineral fuel resources of the State are otherwise limited to the semi-bituminous, Triassic (12) coal of the small Leigh Creek basin.

The best of the Leigh Creek seams (13) averages about 20 ft. of coal carrying 18 per cent. ash and 20 per cent. of moisture displaceable at 105° C. Of this seam the best 6 ft. averages as follows:—

	Per cent.
Moisture lost at 105° C	32·0
Volatile matter	26·4
Fixed carbon	34·7
Ash	6·9
	100·0

This appears to be the best that the Leigh Creek semi-bituminous coal field can produce as a working proposition. So taken into consideration with remoteness from centres of population, it is obvious that the Tertiary brown-coal formations are likely to be the State's mainstay in the matter of fuel resources.

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(12) The occurrence of *Macrotaeniopteris wianamattae* and *Thinnfeldia odontopteroides* in these beds fixes the age as Triassic.

(13) *Vide* Government Geologist's Report, Min. Rev., No. 27.

In general appearance and composition, the Moorlands lignite is very similar to the better known Victorian occurrences—for example, that of Morwell. The latter, however, is freer from ash than any of the South Australian so far examined.

No fossil remains other than plants have yet been detected in the lignite and associated clays of *Division 4* in the Moorlands section. The plant remains in the lignite itself are singularly well preserved, often retaining the woody structures so as to be clearly distinguishable in the hand specimen.

The coal cuts like cheese and, consequently, is easily excavated. In the seam, or when freshly mined, it is of a black or deep chocolate-brown colour, but exposure to the air at the surface soon causes it to dry out, accompanied by contraction which develops shrinkage cracks, eventually leading to a crumbling of the mass. As drying proceeds the general colour becomes lighter until it is literally a "brown coal."

The remains of small trees, sticks, and reeds are clearly distinguishable as blacker lignite embedded in a browner base. The latter is observed to be constituted principally of the remains of leaves and small twigs. Some of these leaves are very fresh and tough, so that they may be picked out in large pieces or even entire. They are so thin and translucent as to be capable of mounting on glass slips as transparencies. Selected examples, thus mounted, have been submitted to an authority on Tertiary floras, Mr. Henry Deane, M.A., F.L.S., who comments upon them as follow:—"Broader-toothed leaves evidently Proteaceous, but not '*Banksia*.' Venation resembles more nearly that of a short leaf among my specimens of *Telopea speciosissima*. Specimens of *Lomatia Fraseri* and *L. ilicifolia* have been compared, but in these the dentation of the margin is invariably too strong. The small narrow leaf bears a strong resemblance to some leaves with entire margins of *Banksia marginata*."

Embedded at random in the leafy base are particles of two varieties of resin. The more abundant is very dark coloured, practically black. It occurs characteristically in large, elongated, tear-like drops, usually about 1 cm. in diameter, but often considerably larger. In its general appearance and occurrence it is akin to certain of the grass tree gums of to-day, but darker in colour, which, however, is a feature which would be expected to develop with age.

In considerably less quantity and in smaller particles of an irregular shape, usually about one-third of a centimetre or less, is a light yellow-brown resin. Like the former, it is brilliant on fracture face but dull externally.

As to the question whether the lignite has grown where it is now accumulated, considerable evidence of growth *in situ* has been observed

Rootlets have been distinctly noted traversing the interbedded lignitic clays. A small stump, about 8 in. across, was got in these beds when excavating the original shaft on Mineral Lease 1233, Hundred of Sherlock Furthermore, the arrangement of the components of the lignitic mass is adverse to any suggestion of water transportation. For example, the particles of resin are embedded at random, and there is no evidence of water sorting as between the leaf remains and the massive woody tissues.

IV. COMPARISON BETWEEN THE BEDS IN SOUTH AUSTRALIA AND VICTORIA.

The Tertiary deposits of the old Murray Gulf appear to extend continuously from the eastern limits of the Mount Lofty Ranges across into the mallee of Victoria. The strata at Moorlands represent depositions on the western side of the old gulf, and a study of the beds is of especial interest for comparison with those on the Victorian side, which latter have already been written upon in regard to the deep borings in the mallee (14)

In the present collection of fossils by far the larger number of marine shells show an aspect comparable to the Aldingan fauna of Professor Tate, both as regards the Lower (Miocene) series and the Upper (Lower Pliocene) beds. On the Victorian side the same deposits, both lower and upper, show the middle and upper part of the Hamiltonian facies,(15) as proved in the deep borings of the mallee. Thus, in the latter locality there were no shells of *Spondylus arenicola*, *Pecten palmipes*, and *P. consobrinus*, although others were common to both localities. This dissimilarity in faunas, so closely adjacent, would suggest a bar or rocky ridge separating the sea of that period. The curious deepening of the bathymetrical sedimentary conditions, shown in the Tintinara Bore, have been referred to as due to trough folding or even to the formation of a rift-valley with infilled material.(16)

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(14) Chapman, F.: Cainozoic Geology of the Mallee and other Victorian Bores, Rec. Geol. Surv. Vict., vol. iii., pt. 4, 1916.

(15) A regional word, here coined to express the combined faunas of the lower and upper Muddy Creek beds with the intercalated limestone of the Grange Burn, ranging from the Balcombian to the Kalimnan.

This present series affords data which help one to divide the Miocene (Janjukian) beds of both the old Murray and the Spencer Gulfs into three sections, as exemplified here and in the Victorian bores of the mallee area:—

(3) Glauconitic bed, yellow clays and sands.

(2) Polyzoal rock, or grey to whitish calcareous sand, passing downwards into a pyritous and quartzose deposit, with marine fossils.

(1) Carbonaceous beds with lignite.

For the present we may regard these as equivalent to the Upper, Middle, and Lower Miocene, respectively, although their limits are not clearly marked.

It is interesting to note here that the order of the Beds 2 and 3 are reversed, as far as lithology goes, at Torquay (Spring Creek beds); but it must also be borne in mind that the molluscan facies from the two glauconitic series would assuredly differ.

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(16) Chapman, F.: Rec. Geol. Surv. Vict., vol. iii., pt. 4, 1916, p. 407.

CONTRIBUTIONS TO THE ORCHIDOLOGY OF AUSTRALIA AND NEW ZEALAND.

By R S. ROGERS, M A., M.D.

[Read July 13, 1922.]

I. ADDITIONS.

Diuris brevifolia, n. sp Planta gracilis, glabra, circiter 15-40 cm. alta. Folia 4-8, linearia v. setacea, acuminata, non torta, erecta, 7-12 cm. longa. Flores 1-4, laxe racemosi, lutei cum notationibus bruneis paucis. Sepalum dorsale ovatum, recurvum, circiter 15 mm. longum; sepala lateralia herbacea, linearia, acuminata, parallela, patentia. Petala breviter petiolata, circiter 14 mm. longa, lamina elliptica. Labellum sepalo dorsali aequale aut paulo longiore; lobus intermedius rhombo-cuneatus, basi intus carina duplici, lateralibus plus quam duplo longior.

Slender, glabrous; leaves generally 4-8, linear or setaceous, acuminate, not twisted, very erect, rarely reaching beyond the middle of the stem. Flowers solitary, or in a loose raceme of 2-4, on slender pedicels, yellow with a few brown markings, much smaller than those of *D. sulphurea*. Dorsal sepal ovate, recurved; yellow with two dark-brown spots on the dorsum, one on each side of the base. Lateral sepals much longer, green, linear, parallel, spreading below the labellum or slightly recurved Petals nearly as long as the lateral sepals, shortly stalked, spreading or recurved; lamina a canary-yellow, elliptical, about 11 mm. long. Labellum yellow, at least as long as the dorsal sepal and generally longer; lateral lobes less than half as long as the central lobe, generally about 5 mm., not very wide, margins entire, tips recurved; middle lobe rhombo-cuneate with depressed antero-lateral margins; lamina with two closely approximated parallel raised lines on the basal half continuous with the anterior central keel, the lines surrounded by a conspicuous dark-brown border Anther without a definite point, rather higher than the viscid disk of the rostellum. Lateral appendages of the column subulate or linear-falcate, about the same height as the viscid disk.

South Australia: Longwood and other parts of the Mount Lofty Range; Myponga; Mount Compass, Port Elliot; Kangaroo Island. November-December.

This plant has long been confused with *D. sulphurea*, which it superficially resembles, but from which it differs in its short setaceous and relatively numerous leaves; in its much smaller flowers and in its labellum, which is at least as long as the dorsal sepal and bears two raised longitudinal lines.

Its relation to other South Australian members of the genus is indicated in the following table:—

- Flowers not blotched or spotted on their upper surface, but of a uniform colour.
  - Flowers purple or heliotrope (drying yellowish-brown); lateral sepals greatly exceeding petals, about 5 cm. long .. .. *D. punctata*
  - Flowers canary-yellow; lateral sepals only slightly exceeding petals ... ... *D. pedunculata*
- Flowers yellow with conspicuous dark-brown or purple-brown markings or blotches.
  - Lateral lobes of labellum large, as long or nearly as long as middle one.
    - Lateral sepals greatly exceeding petals in length, often nearly twice as long; leaves 6 or more, setaceous or almost so ... ... *D. palustris*
    - Lateral sepals shorter than, or approximating in length to the petals; leaves not setaceous.
      - Lateral sepals crossed; blotches generally distinctly demarcated from the yellow ground-colour; 2 longitudinal raised lines at base of labellum ... ... *D. maculata*
      - Lateral sepals nearly parallel; *flowers wall-flower colour,* dark blotches merging into yellow ground-colour; 1 raised line at base of labellum ... ... *D. longifolia*
  - Lateral lobes of labellum very much shorter than the middle one.
    - Two raised longitudinal lines along base of labellum. .
      - Flowers with small dots and short linear markings; leaves linear and rather lax, often 17 cm. long ... ... *D. palachila*
      - Flowers with 2 conspicuous brown dots at base of dorsal sepal and conspicuous oblong brown border round the raised lines; leaves usually more than 5, setaceous or nearly so; short (about 7 or 8 cm.) and very erect ... . *D. brevifolia*
    - One longitudinal raised line along base of labellum.
      - Flowers with similar markings to *D. brevifolia*, and in addition a brown transverse blotch near the tip of middle lobe of labellum; leaves usually 2, rarely 3, long, lax, linear ... . *D. sulphurea*

Prasophyllum Brainei, n. sp. Planta viridis, gracilis, 12-24 cm. alta. Lamina folii basi dilatata, deinde anguste linearis vel setacea, spicae circiter aequalis. Spica laxa, 5-10 cm. longa. Flores 10-24, sessiles, virides, pediculus perbrevis. Segmenta perianthii glandulosa. Sepalum dorsale erectum v. recurvum, ovato-lanceolatum, concavum, acuminatum, circiter 5·75 mm. longum; lateralia libera, patentia, leviter apicibus recurva, circiter 7 mm longa Petala erecta, anguste oblonga v. lineari-lanceolata, circiter 5 mm. longa. Labellum sessile, basi subgibbosum, ad columnam erectum; deinde recurvum sigmoideum, ad apicem contractum et brevissime ciliatum, marginibus crenulatis, pars callosa ovato-lanceolata, marginibus anticis ciliatis, paulum ultra primum flexum producta; pars membranacea latiuscula, alba, inferiore dimidio levis, in superiore dimidio rugosa. Columnae laciniae late oblongae; apicibus obtusis obliquis; rostellum in altidudine excedentes. Anthera rostello brevior.

A slender green plant, 12-24 cm. high. Lamina of leaf dilated at the base, thereafter setaceous or narrowly linear, about same length as the spike. Flowers almost sessile in a loose spike, their very short pedicel subtended by a broad short blunt bract, entirely green, recurved from the axis of inflorescence; ovary 4-5 mm. long, obovate; all segments very glandular. Dorsal sepal erect or recurved, concave, ovate-lanceolate, acuminate, slightly contracted at the base. Lateral sepals quite free, spreading but only slightly divergent, tips slightly recurved, concave on upper surface, narrow lanceolate. Lateral petals erect, narrowly oblong or linear-lanceolate, not very acute. Labellum sessile; rather gibbous at the base, but not protruding between the sepals; proximal part erect against the column, the margins entire until a little beyond the middle; thereafter recurved so as to form a complete sigmoid flexure, laterally contracted towards the apex, the margins crenulate and very shortly ciliate from the first bend to the extreme tip; the callous portion dark green, ovate-lanceolate, extending from the base to a little beyond the first flexure, its termination concealed by the lateral contraction of the lamina at that point, its margins shortly ciliate; the membranous part rather wide, whitish, smooth in the erect part, rather rugose anteriorly, very glandular, more or less tomentose towards the tip. Lateral appendages of the column relatively large, broadly oblong, with blunt oblique tips, basal lobes distinct, exceeding the rostellum in height. Anther shorter than the rostellum.

Named after Mr. A. B. Braine, an ardent collector and student of Victorian orchids.

Victoria: Ringwood (E. E. Pescott). October.

The new species approaches the green forms of *P. fuscum*, but materially differs from it in the much less complicated structure of the labellum and shorter lateral appendages of the latter.

Pterostylis humilis, n. sp. Planta robusta, perbrevis, 2-3 cm. alta. Folia 4-6, rosulata v. subrosulata, sessilia, imbricata, 0·5-2·5 cm. longa, ovata v. oblonga. Flos unicus, sessilis; ovarium basibus foliorum in parte obtectum. Sepalum dorsale ovato-lanceolatum, circiter 15 mm. longum cum petalis connivens. Galea subangusta, apice acutiuscula. Labium inferius oblongo-cuneatum, erectum, sinu acutissimo, lobi subulati circiter 13 mm. longi galeam multo superantes. Labellum unguiculatum, lineari-oblongum, ad apicem obtusum sensim contractum; lamina circiter 11 mm. longum, linea longitudinalis elevata in medio; appendix linearis, curvata, penicillata. Columna circiter 10 mm. longa; anthera terminalis, obtusa, bilocularis, erectiuscula; lobi superiores laciniarum breves lineares, inferiores longi falcati acutissimi. Stigma perprominens, infra columnam mediam, late cordatum, lobis distinctissimis.

A rather stout plant of low stature, arising from two more or less conical or globose tubers. Leaves (in the flowering stage) 4-6, rosulate or subrosulate, sessile, sheathing, imbricate; lamina of varying length, oblong, ovate or oblong-ovate. Flower solitary apparently sessile, the ovary partly hidden by the sheathing bases of the leaves. Dorsal sepal ovate-lanceolate, about 15 mm. long (when extended), connivent with the petals to form a rather narrow erect galea, apex of galea rather acute but not prolonged into a filiform point. The base of the lower lip oblong-cuneate, erect; lobes subulate (hardly filiform), including a very acute sinus, embracing the galea. Labellum reddish-brown, on a movable irritable claw, oblong-linear, tapering a little towards a very blunt and slightly recurved tip; lamina traversed by a raised longitudinal line with a corresponding groove below; basal appendage linear, curved, penicillate. Column (extended) about 10 mm. long. Anther terminal, bilocular, quite blunt, rather erect. Wings of column with a short linear upper lobe or tooth; the lower lobe long, falcate, very acute. Stigma very prominent, situated below the middle of the column; its two lobes very distinct, together forming a broadly cordate disk. Rostellum linear-oblong situated between the bases of the anther loculi and connected to the stigma by a split tube.

New Zealand: The Haunted Whare, near Waimarino (H. B. Matthews).

Mr. Matthews states that his specimens were removed from their natural habitat near the base of Ruapehu (within three miles of perpetual snow), and cultivated in Auckland, 200 miles north of their native locality. He thinks that the change to abnormal conditions may have produced a dwarfed growth in the plant. Along with his spirit specimens, he

forwarded a photograph of a fruiting specimen. This indicates a plant of different habit, with a stature of 11 cm., with leaves on well-marked petioles and lamina from 3·75-6 cm. long. It is probable that the scape becomes elongated after pollination, so as to assist in the maturation of the fruit, as happens in the case of many Australian orchids, notably in the genus *Corysanthes*. On the other hand, it must be remembered, that in certain other species of the genus, dwarfed specimens are by no means infrequent. This is particularly true of *P. cucullata*, where dwarf forms are often to be found growing side by side with normal plants. These show such a departure from the type that even experienced botanists like Sir J. D. Hooker and Robt. Brown fell into error and described them as separate species.

Mr. Matthews further states that unlike other members of the genus, the flower is reversed, the labellum being uppermost, owing apparently to a retroflexion of the column on the ovary.

The new species appears to correspond rather closely to the description of *P. trifolia*, published by Colenso in New Zealand Inst., xxxi. (1898), 281. As only a single specimen of Colenso's plant was discovered, and that is not available for comparison, it is not possible to say whether the two orchids are identical. Cheeseman, however, regards *P. trifolia* as conspecific with *P. venosa*, which differs from Mr Matthews' plant in column and in some other respects.

Caladenia pumila, n. sp. Planta pumilissima, perhirsuta, 5-10 cm. alta. Folium basi amplexicaule, circiter 3-6 cm. longum, hirsutissimum, lineare v. olbongo-lanceolatum. Caulis robustiusculus, hirsutissimus. Flos solitarius, albus, comparate pergrandis. Segmenta perianthii subaequalia, paene glabra, acuminata, non-caudata. Sepalum dorsale lanceolatum, concavum, erectum, incurvatum, circiter 2·5 cm. longum, basi latiusculum; lateralia latiora, libera, patentia, lanceolata. Petala patentia sepalis angustiora. Labellum breviter unguiculatum, ovatum, apice obtusum, obscure 3-lobatum, circiter 15 mm. longum 11 mm. latumque; dimidio inferiore ad columnam erectum marginibus integerrimis, deinde recurvum marginibus carneis serrulatis v. crenulatis; lamina transverse complanata, callis carneis anguste linearibus 4-6 seriatis prope medio terminantibus. Columna circiter 13 mm. longa, incurvata, in dimidio superiore late membranaceo-dilatata. Anthera incumbens, valvata, bilocularis. Pollinia 4, typica.

A very hairy species of low stature. Leaf relatively large, linear or oblong-lanceolate, clasping at the base; stem rather stout, with a rather large free acute bract close to that subtending the terminal pedicel. Flower solitary, white, relatively very large. Segments of perianth white, usually without markings but sometimes with a faint pink stripe on the outside, nearly equal in length, glabrous except at the extreme base, not contracted into caudae, gradually diminishing into finely acuminate non-clavate points, the latter rarely glandular. Dorsal sepal erect, lanceolate, incurved, concave, about 2·5 cm. long, the base rather wide. Lateral sepals wider, free, spreading, lanceolate, somewhat contracted at the base. Petals spreading, lanceolate, narrower than the lateral sepals. Labellum on a short claw, white with narrow pink margins, a few pink splashes on the lateral lobes, obscurely 3-lobed, ovate, blunt at the apex, about 15 mm. long and 11 mm. wide; the lower half erect against the column with entire margins; thereafter recurved with serrulate or crenulate margins; the lamina flattened transversely, the calli pink narrowly linear in 4-6 rows ending near the middle. The column nearly as long as the labellum, incurved, speckled with pink, widely winged in its upper half. Anther shortly mucronate, valvate, 2-celled. Stigma circular, with short triangular rostellum in its upper border between the bases of the anther cells. Pollinia in 2 pairs, of the usual type. Ovary exceedingly glandular-hairy.

Victoria: Bannockburn (E. E. Pescott) September-October.

The new species differs from *C. Patersoni* in its dwarfed habit, in the absence of tentacles to the perianth segments, and in the absence of definite glandular tips to those segments. Its sepals are about equal in length to the petals, whereas they are considerably longer than the latter in *C. Patersoni*. The tip of the labellum is blunt and the margins practically entire in *C. pumila*, whereas the tip is acute and the margins acutely toothed in the other species.

Prasophyllum Frenchii, F. v. M., var **Tadgellianum**, n. var. Flowers pale greenish-yellow; or yellow with chocolate markings down the middle of the perianth segments, also down the middle and on the sides of the labellum. Lateral sepals connate.

Victoria: Mount Hotham (5,100 ft.); Mr. A. J. Tadgell. December, 1914.

New South Wales: Mount Kosciusko (7,300 ft.).; Dr. Green. December, 1921.

The specimens from these two alpine localities would appear to be morphologically identical. In coloration they differ from F. v. M.'s plant, and also from each other The chocolate markings on the Mount Kosciusko specimens are an exceedingly conspicuous feature and give to the flower a very distinctive appearance. Fortunately a single bloom was sufficiently fresh to enable this observation to be made. The Mount Hotham plants were dry, and like many prasophyllums in that condition very difficult to examine. All the specimens differed from the type by the possession of connate sepals. The union or otherwise of these segments is a variable feature in *P. Suttonii*, another alpine member of the genus, and was not considered sufficiently important to indicate a specific difference. It is possible, however, that closer acquaintance with this plant may cause it to be given the higher rank.

Prasophyllum australe, Br., var. **viscidum,** n var Plant slender; flowers rather smaller than the type, dark red or prune coloured, with many darker blotches or spots, very viscid.

Victoria: Alberton, Gippsland; "in sandy soil, swampy in winter time"; Mr. A. J. Tadgell. January(?), 1921.

Of this very interesting and unusual variety, Mr. Tadgell writes:—"It is so viscid, that it is quite a trouble to detach it from the drying-sheet. . . . It is scarred like a leper, on flowers and stem."

Caladenia carnea, Br., var. **aurantiaca,** n var Very slender, about 14 cm. high. Flowers 1 or 2, the second one on a filamentous pedicel Perianth segments white on the inside, striped with green on the outside Labellum pure white with exception of the tip and the calli, which are deep orange in colour; calli in 2 rows, with large clavate heads and slender stalks; tip entire, its margins without denticulations or calli.

Victoria: Alberton, Gippsland, A. J. Tadgell. October, 1920.

The contrasting colours of this dainty little *Caladenia* give it a very characteristic appearance and charm. There are no transverse stripes on the lamina as in the type The stem and ovary are distinctly hairy; the leaf narrow-linear and almost glabrous.

2. NOTES.

DENDROBIUM DICUPHUM, F. v. M. Leaves 4, lanceolate, with 5 prominent nerves, 15-18 cm. long and about 2 cm. wide. Flowers white with purple centre, 9-12, in a raceme on a slender peduncle about 36-40 cm. long. Perianth segments longitudinally veined. Sepals similar, acute, oblong-elliptical, about 16 mm long and 5 mm. wide. Petals obovate, about 18 mm. long and 10 mm. wide. Spur 2-fid; the lower segment oblong-cylindrical, very obtuse, about 3 mm. long. Labellum about 13 mm. long and 10 mm. wide (flattened out); 3-fid; middle lobe obtusely oblong; lateral lobes wide and rounded; lamina with rather numerous calli distributed along the nerves, but chiefly in about 6 rows terminating near the centre, longitudinally veined. *Northern Australia:* Groote Eylandt, Gulf of Carpentaria; Mr. N. B. Tindale August, 1921.

SPIRANTHES AUSTRALIS, Lindl Column erect, about 3 mm long, fleshy, contracted in its lower half, clinandrium dilated; anther valvate, 2-celled, blunt or minutely apiculate, inclined against the back of the stigma and reaching to about its upper border; the wings represented by a membrane on each side stretching between the "filament" of the anther and the stigmatic-plate,(1) adnate to the pedicel ("style") of the latter and also to the lateral margins of the stigma itself, forming a pouch between the male and female elements of the column, the bases of the pollinia released quite early from the anther so as to rest in the bottom of this pouch. Stigmatic surface U-shaped, large and slightly sloping downwards. The rostellum (including the disk) almost equal in length to the stigmatic surface, arising from the upper border of the latter, forming a long narrow membranous structure much exceeding the anther in height; with a short rigid acute bifid base persisting after the membranous portion has been removed, or as a long split membranous structure after removal of the disk and pollinia only. The disk slate coloured, long narrow elliptical (or "boat-shaped") accommodated in a fork of the rostellum and covered by a membranous capsule derived from the latter and containing a viscid fluid; the capsule attached to the lateral margins of the disk and traversed by a central vertical furrow. Pollinia lamellated, in 2 pairs, the latter club-shaped or pyriform, granular; the apices of the pairs lightly united, exposed above the anther-case and attached by a short caudicle to the back of the disk; capsule of disk easily ruptured artificially so as to permit removal of the pollinarium.

The structure of the column in *Spiranthes australis* is comparable to that in the genus *Prasophyllum,* but in the former the wings of the anther-filament are adnate not only to the pedicel of the stigmatic-plate, but also to the margins of the stigma itself.

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(1) Rogers, Trans. Roy. Soc. S. Austr., xlv. (1921), p. 264.

To rupture the capsule of the disk artificially, a light but appreciable force is required. An attempt to produce rupture by 15 minutes' exposure to chloroform vapour, as in Darwin's experiment, was unsuccessful. The facility with which the whole pollinarium may be removed is strongly suggestive of an insect-pollinated plant, yet the examination of large numbers of plants revealed the pollinia still *in situ* and in only one instance was pollen found adhering to the stigma. No difficulty was experienced in removing the pollinia from fully expanded flowers, although R. D. Fitzgerald states that this is impossible. This botanist writes:—"I could discover no trace of a rostellum or disc of any kind. In this flower the persistence with which the pollinia remained behind the stigma, though left naked by the shrinking back of the anther, is very peculiar. No transfer of the substance of the stigma on the point of a pin or a bristle induces them after opening of the flower to come forth for the chance fertilization of another flower. It even requires some violence to break them as the more friable portions turn towards the anther" (Australian Orchids, vol. i.).

In the numerous specimens which I have examined from South Australia, Victoria, and Queensland, the "split rostellum," the "boat-formed disk," the "easily-removable pollinia" of Darwin were all present. In fact, Darwin's description of these structures in *S. autumnalis* may be accepted as a most accurate description of the same structures in the Australian species. The capsule of the disk does not appear to split so readily as in the European species. In no other respect does it appear necessary to modify the great observer's classical description.

It can hardly be doubted that Fitzgerald's observations were conducted on a species with which Australian botanists are unfamiliar, a species which, so far as is known to the writer, is unrepresented in our national collections.

Whether *Spiranthes australis* is self-pollinated or otherwise is a matter which cannot yet be regarded as settled. Undoubtedly a large number of seed capsules are frequently to be found on some spikes, whereas spikes from other localities display comparatively few.

CALOCHILUS PALUDOSUS, R. Br. *Victoria:* Bayswater; Mrs. Edith Coleman. 23/10/21.

THELYMITRA MEGCALYPTRA, Fitzg. *Victoria:* Grampian Mountains; J. W. Audas. 31/10/20.

T. MACMILLANI, F. v. M. This species, which is usually salmon coloured, has been collected by Mr. E. E. Pescott at Bannockburn, Victoria, of a deep rose or crimson colour.

T. LONGIFOLIA, Forst. *South Australia:* Mount Patawarta (3,060 ft. elevation), 365 miles north of Adelaide; Mr. B. B. Beck. 5/10/20.

This represents not only the highest elevation, but also the furthest north at which any orchid has been recorded in this State A few other orchids from the same locality are noted below.

T. GRANDIFLORA, Fitzg. *Victoria:* Nar Nar Goon; J. W. Audas. 18/10/20.

T. URNALIS, Fitzg. *South Australia:* Bugle Ranges; National Park; Dr. and Mrs. Rogers. October, 1921

This orchid was described in 1882, but has never until this season (1921) been reported since its discovery. They correspond in every respect to Fitzgerald's description and illustration, except that the tooth in front of the column is not always present. The plants were not numerous and were found growing alongside of *T. antennifera*, Hook., and *T. rubra*, Fitzg. The flowers are yellow and bear dark-brown stripes on the outer sides of the sepals identical in appearance to those occurring in *T. antennifera*. It is quite possible that the plant may be a hybrid between this and the other species mentioned above.

DIURIS AURÈA, Sm. *New South Wales:* Barrington Tops (5,100 ft.), near Patterson; Mr. A N. Burns. 14/12/21.

D. LONGIFOLIA, Br. With two well-developed parallel raised lines on the lamina of the labellum. The lamina normally bears only one such line. This fact is rather important, because Bentham makes the number of such lines a prominent feature in the classification of the members of this genus. Mr. Max Jacob, who collected these specimens at Cherry Gardens in this State, informs me that they are by no means uncommon this season (1921) in that locality.

PRASOPHYLLUM SUTTONII, Rogers and Rees. In addition to Buffalo Plateau (Victoria), where this alpine species was discovered, it has reached me from the following localities:—

New South Wales: Mount Kosciusko (7,300 ft.); Mr. R. Helms. February.

Victoria: Baw Baw Mountains (5,060 ft.); Mr. C. French, jun., January; Mount Feathertop (5,000 ft.); A. J. Tadgell, December.

Tasmania: Summit of Ben Lomond (5,000 ft.); A. Simson. March.

Further acquaintance with this orchid shows that the lateral sepals are not always free, but are subject to variation, as in certain other members of the genus.

P. AUSTRALE, Br. In this species, as in *P. elatum*, the lateral sepals are very consistently connate. A departure from this rule is noted in the case of certain specimens collected by Messrs. E. E. Pescott and C. French, jun., at Monomeith, Victoria, among which there are a number of flowers with five sepals.

P. BREVILABRE, Hook f. *Victoria:* Mount St. Bernard (4,000 ft.) and Mount Hotham (5,000 ft.), Australian Alps; Mr. A. J. Tadgell. December, 1913.

PTEROSTYLIS PYRAMIDALIS, Lindl. *Western Australia:* Jarnadup; Miss Knox-Peden. 1/9/21.

All of these specimens are unusually tall, some attaining a height of 33 cm.; the plant quite slender and erect. Leaves at the base 3 or 4, ovate, acute, not strictly rosulate, shortly petiolate or clasping, passing into leaf-like sessile alternate bracts, ovate to lanceolate in shape, diminishing from below upwards, the lower ones generally with serrulate or crenulate margins, sometimes 16 in number. Flower much larger than that of *P. nana;* the galea from base to crest often nearly 2 cm. long. The inturned tooth between the lobes of the lower lip appears to be invariably present, but in other respects the general habit of the plant is very different from that of *P. nana.*

P. CYCNOCEPHALA, Fitzg. *New South Wales:* Mount Kosciusko (7,300 ft.); Dr. Green. 29/12/21.

P. PEDOGLOSSA, Fitzg. *Tasmania:* Brown Mountain, Port Arthur; Miss A. L. Rogers 2/5/19.

P. MITCHELLI, Lindl. *South Australia:* Mount Patawarta (3,060 ft., 355 miles north of Adelaide); Mrs. R. S. Rogers. 14/10/15.

P. RUFA, Br. *South Australia:* Mount Patawarta (3,060 ft., 355 miles north of Adelaide); Mr. B. B. Beck. 5/10/20.

Labellum on a very wide and elastically membranous claw, longer and narrower than usual, very hairy, the hairs of exceptional length.

CORYSANTHES, sp. (?) Capsules dehiscing, on slender pedicels, 13-15 cm. long. The remains of the flower enabled me to identify the genus but not the species. The plants were sent from a Victorian locality, and are of interest in showing how the pedicel, which is almost sessile during the flowering season, becomes enormously elongated in order that the seed capsule may receive the benefit of wind and sun in the process of maturation. Corysanthes blooms in June or

July, and the specimens were collected by Mrs. Edith Coleman in December. Members of the genus propagate chiefly by the vegetative method, and such specimens as these are rarely found.

CALADENIA DILATATA, Br. *South Australia:* Mount Patawarta (3,050 ft.); Mr. B. B. Beck. 5/10/20.

C. GLADIOLATA, Rogers. *South Australia:* Cherry Gardens; Mr. Max Jacob. 26/9/21.

This plant was discovered at Hornsdale, 175 miles north of Adelaide. It has not hitherto been recorded from any other habitat.

CHILOGLOTTIS GUNNII, Lindl. *New South Wales:* Mount Kosciusko (7,300 ft.); Dr. Green. 29/12/21. *Victoria:* Australian Alps (Mount Hotham 6,000 ft., and Mount St. Bernard 5,100 ft.); Mr. A. J. Tadgell. December, 1913.

THE PHYSIOGRAPHY OF THE MEADOWS VALLEY, MOUNT LOFTY RANGES.

By E. O. TEALE, D.Sc.

(Communicated by Professor W. Howchin.)

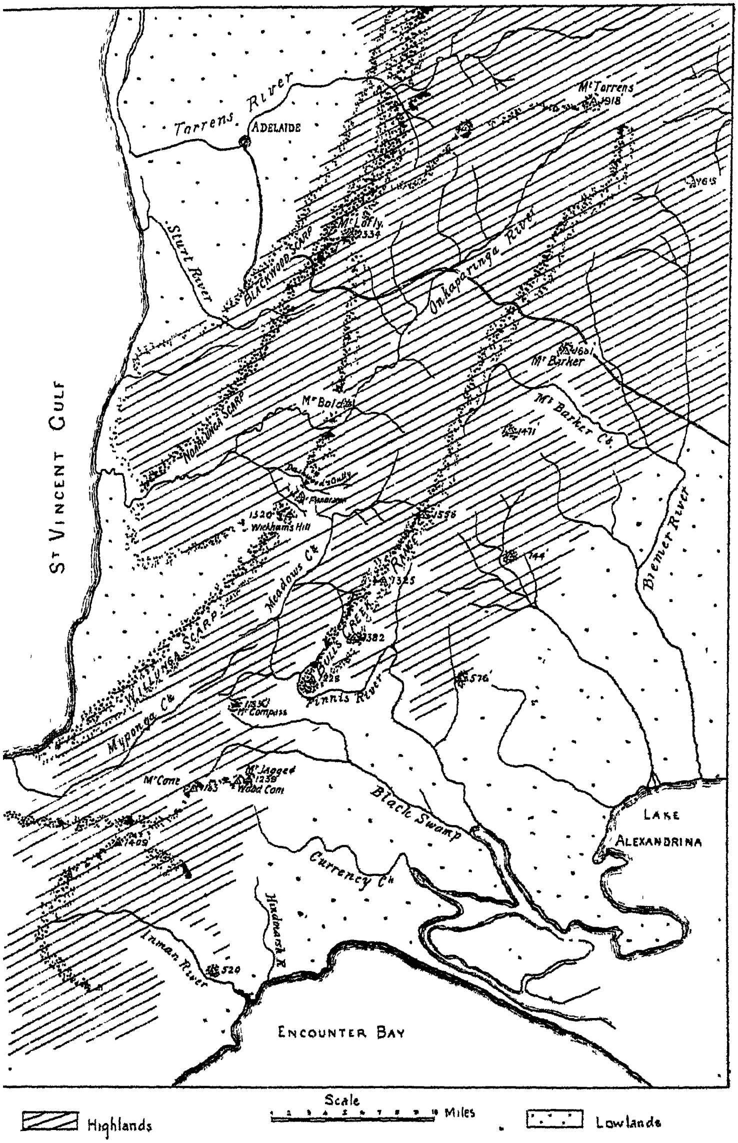
[Read July 13, 1922.]

The broad outlines of the development of the physiographical features of South Australia have been admirably traced out by Prof. Walter Howchin.(2) Relics of ancient topography, and the deposits of "dead rivers" have been widely recognized, and in piecing this evidence together, the great importance of tectonic movement in the form of warping and faulting has been rightly emphasized, for it has certainly had an important influence in the development of the existing conditions of climate and topography The highlands of the Mount Lofty Ranges provide a noteworthy example in this direction They were recognized by Howchin as owing their origin to block faulting, whereby several segments moved differentially with regard to each other.

Remnants of very ancient and mature topography are still to be found alongside of fresh and youthful features, where erosional activities, revived by differential earth movements, are energetically working towards the destruction of those relics which throw so much light on the past geographical history of the region.

The observations of this paper centre around the Meadows Valley, in the southern portion of the highlands, and were gathered by the writer(3) during his geological and soil survey of the Kuitpo Forest Reserves and their vicinity.

The nearest part of this region to Adelaide lies about 20 miles in a straight line to the S.S.E., and the valley trends in a S.S.W. direction for 10 or 12 miles, eventually joining the Finniss River through a narrower and more steeply graded course. It is a broad, flat-bottomed, mature, high-level valley, with its floor at nearly 1,000 ft. above sea level, and covered with a thick deposit of clay resting on grit and waterworn gravel. Remnants of drift material consisting of sand and waterworn gravel with occasional large boulders are also found at varying heights above the bottom of the valley, and clearly do not belong to the present stream conditions. The boundaries of the valley to the east and west are sharply defined by two parallel ridges, remarkably straight and of even height—the Bull Creek Range, on the east, and the Wickham Hill


Torrens River
Adelaide
Mt Torrens
1918
Sturt River
Blackwood Scarp
Mt Lofty
2334
Onkaparinga River
1681
Mt Barker
Mt Barker Ck.
1471
St Vincent Gulf
Noarlunga Scarp
Mt Bold
Dashwood's Gully
Mt Panorama
1320
Wickham's Hill
1558
Meadows Ck
Range
1325
Bull's Creek
1382
1228
Finniss River
744
Bremer River
576
Willunga Scarp
Myponga Ck
1330
Mt Compass
Mt Cone
1183
Mt Jagged
1238
Wood Cone
Black Swamp
Lake Alexandrina
1409
Currency Ck
Hindmarsh R.
Inman River
520
Encounter Bay
Scale
1 2 3 4 5 6 7 8 9 10 Miles
Highlands
Lowlands

Ridge on the west. The latter is really part of the Willunga fault scarp, and its steep western slope is in striking contrast to the topography of the valley under discussion

The eastern side of the Bull Creek Range also presents a more broken character, consisting of dissected hill country, dropping rapidly to the Murray Plains. These ridges are clearly remnants of a once extensive peneplain, dislocated by faulting to the west and east.

They extend northwards beyond the region of the Meadows Valley and form the east and west boundaries of the Onkaparinga Valley in its upper course. There is no sharply-defined watershed between the head of the Meadows Valley and the middle course of the Onkaparinga, and the features are such as to suggest that an ancient north and south valley of mature type and considerable size at one time flowed from the north through the Meadows Valley, and the deposits in its floor and along its sides also demand such a river If this be so, where was the southern outlet, and when and under what condition was the present system developed? The upper course of the Onkaparinga has every feature of an ancient mature valley, and is so regarded by Prof. Walter Howchin.

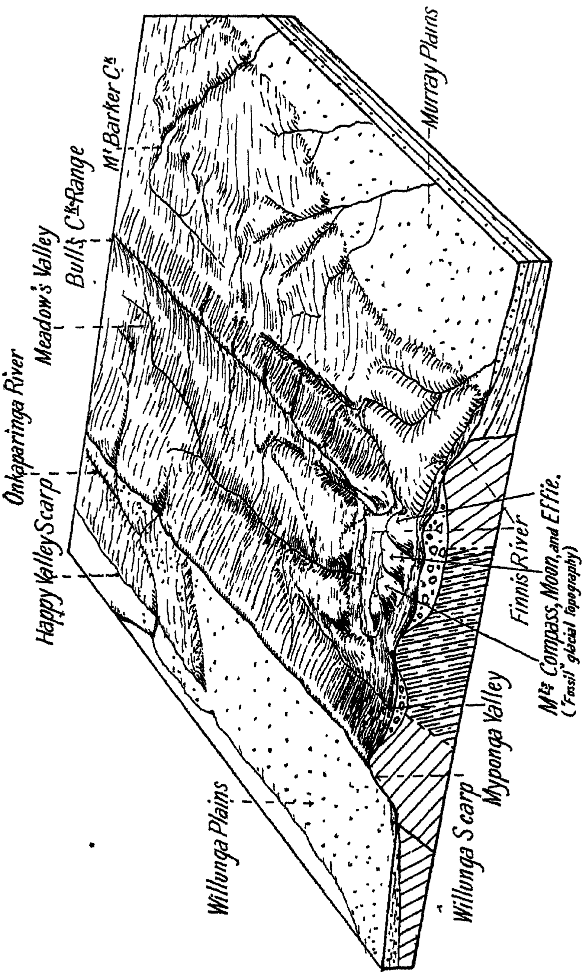
To the north of Mount Bold it begins to turn more westerly and soon leaves the line of the old valley, which continues southerly. The western ridge is breached to the north of Mount Bold, and through it the Onkaparinga escapes as a deep, steep-sided valley of young character, which it maintains almost to its mouth.

Prof. Walter Howchin considers it, in part, an antecedent stream whose lower course during the period prior to the Mount Lofty uplift was an ever-changing one over a wide fluviatile plain. The extensive deposits of alluvium, gravel, and waterworn boulders of the Kangarilla flats and McLaren Vale represent, in his opinion, a more southerly course of the river. At the time of the uplift its position on the flood plain had migrated to that it now occupies, and hence it became incised in a rising segment of the highlands.

The drift deposits of the Meadows Valley, though now 1,000 to 1,200 ft. above those of the Willunga Plain, strongly suggest a dislocated section of that ancient flood plain.

At that period the ancestor of the present Onkaparinga had a more continued north and south direction. The Meadows Valley would thus represent a dismembered section of that drainage system which, eventually, became choked to the brim with fluviatile material. The ever-shifting course of the old Onkaparinga tending to a more westerly direction may have been assisted by early warping preceding the later block faulting.

There is further a suspicion that there is also a faint relic of earlier topography, dating back to the glacial conditions of Permo-Carboniferous times, now almost obliterated by the later cycles that have been superimposed upon it.



Block Diagram

Section of southern portion of Mt Lofty Highlands showing topography and drainage system in relation to structure and tectonic control.

The evidence for this lies in the finding by the writer of a glaciated boulder in a pebble deposit in a small road cutting, near Dinglebedinga School, in the south-western portion of the area. This boulder was accepted as glacial by Prof. Howchin, into whose charge it was given Is this a fluvio-glacial deposit of Permo-Carboniferous age, or is it a Tertiary bed composed, in part, of redistributed glacial? If the latter, did it come from the glacial deposits of the Finniss River, to the south? This would mean a reversal in direction of the present drainage. It is much more probable that the glacial deposits of the south, though extensive, are nevertheless a small remnant of a sheet of material which once extended much farther north, and the Meadows Valley may, in part, be a trough the earliest features of which were due to glacial erosion in Permo-Carboniferous times—a much more imperfect example of "fossil glacial topography," however, than that of the Finniss River district, described by Prof. Howchin, where erosion has laid bare a portion of an ancient landscape with remarkable precision.

What, then, is the past geographical history of this region? Briefly it appears to be as follows:—The Meadows Valley is regarded as a small dismembered portion of an ancient north and south stream the southern course of which, beyond the area under consideration, has not been traced but indications of it might be expected in the direction of Myponga Creek.

This valley existed before the uplift of the present highlands, and in the Meadows Creek section there is some probability that its course coincided with a much more ancient glacial valley partly filled with till.

Peneplanation advanced to a mature stage with consequent aggregation and filling up of the old valleys, resulting in the formation of an extensive piedmont plain over which the streams flowed independently of the underlying structure. Early subsidences and warping may have assisted in the institution of the diagonal direction of drainage, as shown by the present positions of the Torrens and Onkaparinga. Fault block dislocation followed, with the gradual establishment of the present distribution of highland and plain, giving rise to a revived erosion cycle and the entrenching of the deeply-cut river valley into the rising segments. The existing cycle is one of discordances of level and active erosion along the fault scarps, providing short, steep, actively-eroding streams tending to cut back into the old topography and divert remnants of the old north and south valleys into steep-graded easterly or westerly flowing streams.

The north and south strike ridges of hard rock delayed this process, but weak places were eventually found. The most important of these was the southern continuation of the Bull

Creek Range, where the hard Cambrian or Pre-Cambrian rocks gave place to softer Permo-Carboniferous deposits. This led to an eastern breach by what is now the Finniss River, thereby capturing the lower course of the Meadows Valley. The remarkable course of this river has been referred to by Prof. Howchin.(1) The same process can be studied on the western side, but in a less advanced stage, in several small streams, which have actually breached the scarp, but have not yet captured much of the drainage of the old valley. The most notable of these is Dashwood Gully. Peter Creek, heading in the northern Kuitpo Forest Reserve, shows the same features.

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SOME NEW RECORDS OF FUNGI FOR SOUTH AUSTRALIA.
PART II.
TOGETHER WITH A DESCRIPTION OF A NEW SPECIES OF *PUCCINIA.*

By T. G. B. Osborn, D.Sc., Professor of Botany,
and
Geoffrey Samuel, B.Sc , Assistant Lecturer and
Demonstrator in Botany, University of Adelaide.

[Read August 10, 1922.]

Plate VII.

In 1915 one of us published a short note on "Some New Records of Fungi for South Australia." In it were listed some forty species the occurrence of which in the State was not recorded in the literature dealing with Australian fungi.

The present paper adds fifty-one species to the fungus flora of the State and adds nine names to the host species of Australian fungi. Many of these are common, whilst a few have already been mentioned in the Annual Reports of one of us, and their place in this list is merely a matter of convenience, since these Reports are difficult of access to most mycologists. Others of the species, however, are of more interest, because of the apparent rarity of the fungi in other parts of Australia, and one of them, *Puccinia semibarbatae,* occurring on the native *Bulbine semibarbata* (Liliaceae), is new to science.

Following the arrangement of the previous list, reference is given to McAlpine's Systematic Arrangement of Australian Fungi, by the number assigned there, and also, where possible, to other of McAlpine's works, in order to render it easy to ascertain the range of a species in other States. It is hoped to follow this paper shortly by another of a similar type, which will bring the published records of South Australian parasitic and micro-fungi into line with local knowledge.

UREDINEAE.

Uromyces danthoniae, McAlp. On leaves, leaf-sheaths, and panicle-branches of *Danthonia semiannularis,* R. Br. *(Danthonia penicillata,* F. v M., comp. sp.). II., III. Minnipa, Oct., 1916, W. J. Spafford. Also on *Danthonia setacea,* R. Br., which is a new host plant. South Park Lands, Adelaide, Nov. 2, 1916, T. G. B. O. (McAlp., 1906, p. 85).

UROMYCES BULBINIS, Thuem. Teleutosori on flowering scapes and leaves, amphigenous, small, densely gregarious, frequently concentrically arranged in large circles; at first covered by ashen-coloured epidermis, later exposed, firm, convex, brown.

Teleutospores globose to ovate, pedicellate, wall smooth, rather thick, 18-25 × 20-22 μ; pedicel deciduous, hyaline to yellowish, 3-5 μ wide × 3-8 μ long.

On leaves and scapes of *Bulbine bulbosa*, Haw. National Park, Belair, Sept -Oct., common (fig. 1)

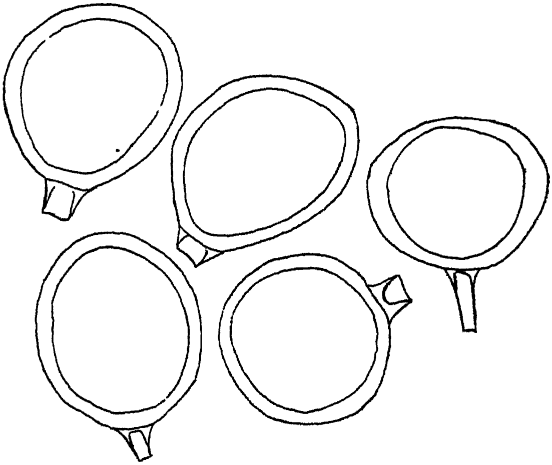

Fig. 1.

Teleutospores of *Uromyces bulbinis*, Thuem. **Drawn** from fresh material (×1100).

This species was described by Thuemen in Flora, 1877, and is given by Cooke, Handbook of Australian Fungi, No. 1738; also by McAlpine, 1906, p. 87. The localities given by the latter are: Victoria, Omeo; New South Wales, Upper Macquarie River.

This rust would appear to be uncommon, for McAlpine says he has not seen a specimen. It is abundant on its host in parts of the National Park, Belair, affecting the leaves and basal parts of the stems, and occasionally sori have been found in the flowering region. The appearance is highly characteristic, the ashen-coloured young sori showing plainly on the yellow-orange infected portion of the host. The compound sori are occasionally very large, in one case 14 × 2 mm.; sometimes a second ring of confluent sori surrounds the first.

We cannot understand the statement in the descriptions cited above that the sori are "concave," for when fresh they project above the surface of the lesion, whilst the teleutospores in all cases examined by us are distinctly globose or ovate, not "clavate or oblong-clavate," and no case of an acute apex has been seen. The spore measurements of the South Australian specimens are rather smaller than those given by McAlpine and Cooke. Since the fungus is so characteristic in its growth, and the only rust affecting *Bulbine bulbosa* on record, there can be no doubt of the species. Possibly the lack of fresh material by Thuemen may account for the discrepancies

UROMYCLADIUM TEPPERIANUM, (Sacc.) McAlp. On stems of *Acacia armata*, R. Br. Common in Adelaide district; Victor Harbour, Aug., 1915; Athelstone, Aug., 1917, T. G. B. O.

On *Acacia calamifolia*, Sweet. Between Port Augusta and Iron Knob, Aug. 22, 1921, J. B. Cleland. Galls abundant on the needle-like phyllodes as well as on the smaller twigs. New host plant.

On *Acacia pycnantha*, Benth. Millicent, April 7, 1917, T. G. B. O.; Meadows, 1921, Ambleside, 1921, G. S.

The brown potato-like galls of this fungus on trees of the golden wattle (*A. pycnantha*) are so conspicuous that it is surprising that no South Australian record of it exists previous to 1917. It must have been present some years before then, for it was becoming a serious menace to the wattle bark-stripping industry in the neighbourhood of Meadows about that year. In 1918 severe bush fires swept this area, and the wattles which came up after the fire were perfectly free from the fungus. During the last year or two, however, galls have begun to appear on isolated trees again, and the fungus will, no doubt, gradually spread. In this connection it is interesting to note that trees may be seen loaded with the rust-galls, yet surrounded by trees which are perfectly free from them. Once a gall has formed on a tree, the fungus spores which are produced on its surface probably become splashed about in the rain drops, under conditions suitable for germination and infection. Thus the tree soon develops numerous galls. Spores will usually be carried to other trees, however, by the agency of wind, which evidently does not lead to those trees becoming rapidly infected (McAlp., 1906, p. 111).

PUCCINIA BROMINA, Eriks. On living leaves and leaf-sheaths of *Bromus arenarius*, Labill. Minnipa, Oct., 1916, III., X. McAlpine says mesospores comparatively rare, but in this specimen they were fairly numerous (McAlp., 1906, p. 116).

PUCCINIA FLAVESCENTIS, McAlp. On living leaves of *Stipa scabra*, Lindl., var. *auriculata*, II. Also on *Stipa pubescens*, R. Br., II., Sept. 23, 1921, W. J. Spafford. Both these are new host species for the fungus. *Darluca filum* was parasitic on the uredosori (McAlp., 1906, p. 119).

Puccinia semibarbatae, n. sp.

Teleutosori on stems and leaves, amphigenous, small, up to 2 × 1 mm., gregarious, occasionally arranged in concentric groups, covered by epidermis, convex, becoming exposed, firm when fresh, but becoming powdery when dry, deep brown-black.

Teleutospores irregular, fusiform, obovate, or sub-globose; apex generally rounded and not thickened, often conical or truncate; rounded at the base, or slightly attenuated; more or less constricted at the septum, dark chestnut-brown: surface with irregular reticulate ridges and depressions; 33-48 μ × 19-26 μ.

Pedicels short, deciduous, slightly tinted.

On living stems and leaves of *Bulbine semibarbata*, Haw. Minnipa, Central Eyre Peninsula (S. Austr.), 1915 (fig 2).

This rust, which has very characteristic telia, occurred in quantity upon the plants of *Bulbine semibarbata* growing around the granite outcrops at Minnipa Hill, on the Government Experimental Farm, Central Eyre Peninsula. It has not been found on its host on the eastern side of Spencer Gulf.

PUCCINIA SACCARDOI, Ludw. On living leaves of *Goodenia amplexans*, F. v. M., I., III. Rosetta Head, near Victor Harbour, Nov., 1915, T. G. B. O. This host plant is not given by McAlpine. The rust is exceedingly common on its host in this locality, the aecidia forming large circular patches up to as much as 15 mm. diameter on both sides of the leaf. The teleutosori occur with the aecidia, usually confluent, often forming two, rarely more, concentric rings, usually towards the circumference of the aecidial patch (McAlp., 1906, p. 147).

PUCCINIA ANGUSTIFOLIAE, McAlp. On *Podotheca angustifolia*, Less., I., III., X. Wirrega R.S., Oct., 1916, T. G. B. O.

By a curious confusion in the synonymy of the host plant, McAlpine gives the name as *Scorzonera angustifolia*, L. The error seems to have arisen in the following manner:—The genus *Podosperma*, Labill., 1806, becomes *Podotheca*, Cass., 1822, since *Podospermum*, DC., was already a synonym for *Scorzonera*, L. (Index Kewensis). *Podotheca (Podosperma)*, belonging to the Compositae Inuleae-Gnaphalinae, is a genus endemic to Australia, and is the host of the native rust considered *Scorzonera*, of course, belongs to the Compositae Chicorieae-Leontodontinae The native Australian flora contains but one genus (*Microseris*) belonging to the sub order Chicorieae

By the kindness of Mr C C Brittlebank, of the Department of Agriculture, Victoria, we have been allowed to examine McAlpine's type specimens collected at Dimboola, Victoria, Nov , 1892 There is no doubt that the fungus

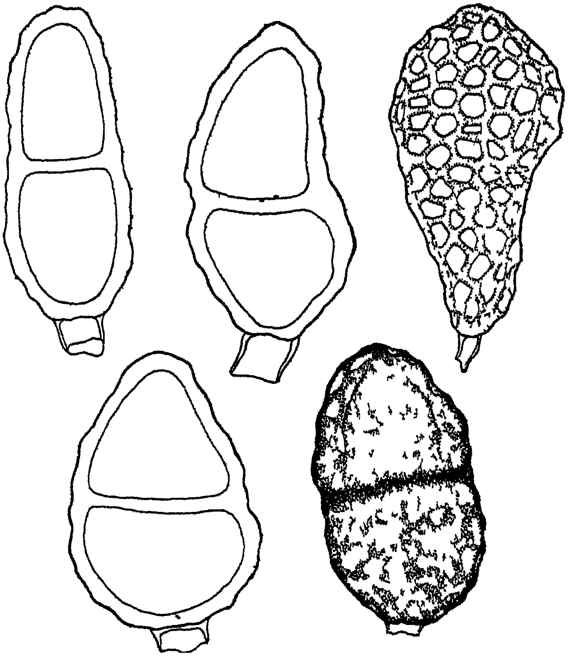

Fig 2
Teleutospores of *Puccinia semibarbatae*, n sp (×1000).

and host plant from Wirrega (S Austr) are the same. McAlpine's note that *P angustifoliae* differs from *P podospermi*, DC , *P scorzonerae*, (Schum) Jacky, and *P tragopogi*, (Pers) Corda, in certain particulars is not surprising, considering how widely removed the hosts are in affinity (McAlp , 1906, p 150)

Puccinia calendulae, McAlp On living leaves of *Calendula officinalis*, L , I Mount Crawford Estate, Jan , 1916 (McAlp , 1906, p 151).

Puccinia erechtites, McAlp. On leaves and stems of *Erechtites quadridentata*, DC. Between Coromandel Valley and Clarendon, Sept. 23, 1916, T. G. B. O. I. and III. intermixed, mostly on the leaves. A number of three-celled teleutospores are present in this specimen. Also Eden Hills, Oct , 1917, Miss A. H. Rennie. I., numerous on stems, present also on leaves and involucre; III., rare.

On *Erechtites prenanthoides*, DC. Blue Lake, Mount Gambier, Oct. 12, 1916, A. G. Edquist. I. only, in groups on both surfaces of leaves (McAlp., 1906, p. 157).

Puccinia vittadiniae, McAlp. On living leaves of *Vittadinia australis*, A. Rich. Wirrega R.S., Oct. 1, 1916, T. G. B. O. I., III., and X. on both surfaces of leaves. As recorded by McAlpine, the teleutosori were sparsely developed; occasionally four or five were observed confluent and forming a ring about 2 mm. diameter round aecidia (McAlp , 1906, p. 164).

· Puccinia opercülariae, (Morr.) Syd.

Teleutosori confluent, 3-5 mm. long, forming patches completely investing the stem; sori elongate, compact, bullate, reddish-brownish, surrounded by the ruptured epidermis.

Teleutospores golden-brown, oblong to clavate, slightly constricted at the septum, smooth, 45-52 × 15-18 μ. Upper cell rounded, apex thickened, hyaline cap (7-9 μ) disappearing when germinating. Lower cell about as long as the upper, tapering to pedicel; pedicel persistent, 22-50 μ long, 3-4 μ broad.

Mesospores occasional, similarly coloured to teleutospores, fusiform to ovoid, apex thickened with prominent hyaline cap, 38-45 × 14-18 μ.

On stems of *Opercularia varia*, Hook f., III. and X., Mount Compass, Oct., 1916, T. G. B. O. (fig. 3).

This fungus was only found on the stems, where the patches of telia formed prominent fusiform swellings, often in the middle of the long internodes of the host. The species is a Lepto form, the majority of the spores being found with the promycelia, or already empty. We have referred the rust to *P. operculariae*, (Morr.) Syd., though it may be that Morrison was right in considering this a variety of *P. coprosmae*, Cooke. Groups of confluent teleutosori on the leaves are a feature of the latter species; this feature is not noted by McAlpine for *P. operculariae*, nor are mesospores which occur in our specimens (McAlp., 1906, p. 166).

Puccinia hibbertiae, McAlp. Teleutosori on stems, leaves (amphigenous), pedicels, and calyces, causing hypertrophy of stem, densely gregarious, confluent. At first covered by the greyish epidermis, bursting, bullate, compact, rounded to oval, rarely exceeding 1 mm., chestnut-brown to black.

Teleutospores elliptical, thickened at the apex, constricted at the septum, wall smooth, 27-37 × 16-21 μ. Pedicel deciduous, sometimes excentrically displaced, 60-110 μ.

Mesospores occasional, similarly coloured to the teleutospores, fusiform, generally thickened at the apex, 26-33 × 12-16 μ.

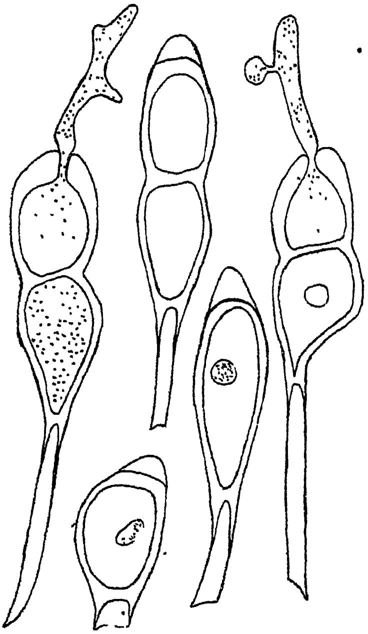

Fig. 3.

Teleutospores and mesospores of *Puccinia operculariae*, (Morr.) Syd. Drawn from fresh material (×

On *Hibbertia stricta*, R. Br., var. *canescens*. National Park, Belair, Oct. 28, 1916, T. G. B. O. New host species.

The fungus here described has been recorded under McAlpine's species *P. hibbertiae*, though it differs from it in the size of the spores, which are consistently shorter in our specimens. In other respects it conforms to McAlpine's description (McAlp., 1906, p. 185).

AECIDIUM OLEARIAE, McAlp. On stems of *Olearia axillaris*, F. v. M., I., on stems only. Victor Harbour, June 16, 1918, T. G. B. O. (McAlp., 1906, p. 197).

USTILAGINEAE.

USTILAGO CYNODONTIS, P. Henn. Destroying the inflorescences of *Cynodon dactylon*, Pers. Mile End, Jan., 1918, G Quinn.

Although the host plant of this fungus is widely grown for lawns, and occurs wild on dunes in many places, the fungus had not been recorded in South Australia before. It has since been found on many occasions in gardens around Adelaide during the summer (McAlp., 1910, p. 155; Osborn, 1918, 1921).

USTILAGO TEPPERI, Ludw. Sori on inflorescences while still enclosed in abnormally numerous sheathing leaf-bases, forming a compact black mass in which generally only the axis of the inflorescence remains of the host. Spore mass ultimately exposed by decay of the leaf-bases and becoming powdery.

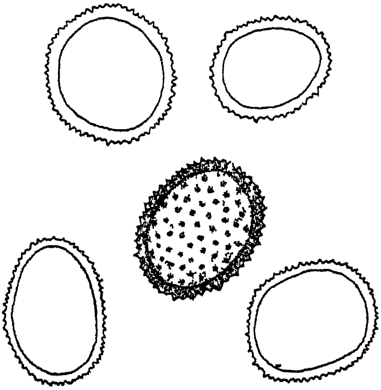

Fig. 4.

Spores of *Ustilago Tepperi*, Ludw. (×1100).

Spores brown, globose to ellipsoidal, finely echinulate, 10-14 μ.

On *Neurachne alopecuroides*, R. Br. Burnside, Nov., 1916; Moppa Scrub, Oct. 1917.

A smut on *Neurachne alopecuroides* was sent to Ludwig by J. G. O. Tepper from Torrens Gorge, South Australia, who described it in 1889 The fungus appears to have a limited Australian distribution, for McAlpine, in 1910, said he had not seen any smut on that host. In November, 1916, it was first found at Burnside, some six miles south of the type locality, and later in the Moppa Scrub, some 30 miles to the north. In both localities it is locally common.

The infected inflorescence is very characteristic (pl. vii., fig. 2). The normal host produces an inflorescence at the end of a long bare peduncle, as much as 25 cms. above the highest leaf. The lamina of the leaves at the base of the peduncle is short (2-3 cms.), with a leaf-base of almost the same length. The infected inflorescences have scattered leaves over their entire length, and a group of three or more leaves terminating the stem. The laminae of those are 1-2 cms. long, with rather longer leaf-bases closely investing the diseased inflorescence. There is thus a characteristic gall-like development (McAlp., 1910, p. 161) .

CINTRACTIA HYPODYTES, (Schl.) Diet. On stems of *Stipa flavescens*, Labill. Granite Island, Jan. 3, 1919, T. G. B. O.

Occurring especially on the upper internodes, within the sheathing leaf-bases, and preventing the formation of an inflorescence (McAlp., 1910, p. 171).

UROCYSTIS HYPOXIDIS, Thaxt. On leaf-bases and inflorescences of *Hypoxis pusila*, Hook, f. Grange, June 2, 1917, T. G. B. O.

New host species. The fungus has been recorded from Victoria on *H. glabella*, but it has not been observed on the latter in South Australia, though the plant grows commonly in the Adelaide district (McAlp., 1910, p. 197).

BASIDIOMYCETES.

AUREOBASIDIUM VITIS, var. ALBUM, Montmart. On leaves, young shoots, and inflorescences of *Vitis vinifera*, L. Lyrup, Watervale, Berri, Renmark, Oct., 1921.

In October, 1921, specimens of young vine leaves were sent in from several localities, exhibiting blackened areas of irregular extent. If placed in a moist dish, these rapidly spread over the whole leaf, and whitish pustules consisting of basidia bearing spores on sterigmata formed both on leaf surface and fruit stalks. In the original description (1882) of *Aureobasidium vitis*, Vial. et Boy., the fungus was described as being clear yellow; but in 1897 Montemartini (1) described a variety occurring on leaves and fruit stalks which he named *A. vitis*, var. *album*, because the pustules were whitish. Later in that year, McAlpine described a form occurring in Victorian vineyards, chiefly on the berries, as *A. vitis*, var. *tuberculatum*. The South Australian specimens, both in the parts affected and in the nature of the spore pustules, agree most closely with Montemartini's description, so that the above name is given them (McAlp , 1897, p. 16).

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(1) Montemartini, in: Atti dell' Istit. botan. dell' Università di Pavia, 1897 (ref., Zeitschr, f. Pflanzenkrank., vii., p. 359, 1897).

ASCOMYCETES.

Erysiphe cichoracearum, DC. On *Senecio vulgaris*, L. Glencoe, South-East, Dec. 9, 1916, G Quinn.

On living leaves and stems of *Cucurbita pepo*, L Murray Bridge, Feb., 1917. Also common in gardens in Adelaide on the marrow and other types of *Cucurbita*.

Not listed by McAlpine (Osborn, 1918).

Asterina baileyi, Berk. et Br On living leaves of *Hakea rostrata*, F. v. M. Belair, Sept , 1920, G. S. And on *Hakea ulicina*, R. Br. Forest of Kuitpo, May, 1922, G. S.

This is a common fungus, and has been present here for years, though not recorded for South Australia as yet. A specimen of *H. ulicina*, in the Herbarium of the University of Adelaide, labelled "Aldgate, 1895, O. E. Menzel," is affected with it. The Hakeas above are new host species (McAlp., 1895, No. 1728).

Seynesia banksiae, McAlp. On the upper surface of living leaves of *Banksia ornata*, F. v. M. Forest of Kuitpo, May, 1922, G. S. (McAlp., Proc. Linn. Soc. N.S. Wales, 1903, p. 553).

Parodiella banksiae, Sacc et Bizz. On leaves of *Banksia marginata*, Cav. Ambleside, May, 1922, G. S.

This fungus, known as Banksia Freckle, occurs on the under surface of the leaves, chiefly the lowest or innermost leaves, slightly "languid," as McAlpine says. Although it has not been recorded for South Australia before, it has been present here for years. A specimen of *Banksia marginata*, in the Herbarium of the University of Adelaide, labelled "Aldgate, 1895, O. E. Menzel," is infected with it (McAlp. 1895, No. 1741).

Oidium, on apple. On living leaves and twigs of *Pyrus Malus*, L. Upper Sturt, Jan., 1921, G. S.; Houghton, Mar., 1921, G. S.

At Houghton the *Oidium* was unusually plentiful on big leafy trees 12 to 15 ft. high which had only been single-worked, and were probably on their own roots.

The perfect stage of this *Oidium* was not found. There are four apple mildews—*Podosphaera oxycanthae*, *Podosphaera leucotricha*, *Podosphaera tridactyla*, and *Sphaerotheca mali*—over which there has been considerable confusion; until the perithecia are found, therefore, this *Oidium* cannot be named. In McAlp., 1895, No. 1721, *Podosphaera tridactyla* is recorded for Victoria and New South Wales (Osborn, 1919).

FUNGI IMPERFECTI.

SPHAEROPSIDACEAE.

Coniothyrium acaciae, McAlp. On living phyllodes of *Acacia pycnantha*, Benth National Park, Belair, July, 1922, G. S

Darluca filum, Cast. This fungus, which is parasitic on the uredosori of rusts, has not been specifically recorded for South Australia before, but has probably often been found. Thus McAlpine notes it as common on the uredosori of *Puccinia Lolii*, and also gives Mount Gambier, South Australia, as one locality for this rust; the same note occurs in his descriptions of several other rusts. In our material, *Darluca filum* occurred on *Puccinia flavescentis*, a host which is not recorded in McAlpine, 1906, p. 119, as well as on many other species of *Puccinia* (McAlp., 1895, No 2087; McAlp., 1906, p. 22).

Diplodia citricola, McAlp. Forming scabs on the fruit of *Citrus aurantium*, L. Together with *Phoma omnivora*, Torrens Park, Mitcham, Nov. 21, 1919. Alone, Clarendon, Jan., 1921, G S. McAlpine does not record its attacking the fruit (McAlp., 1899, p. 83; Osborn, 1919).

Kellermannia pruni, McAlp. Saprophyte on decaying almond leaves on the ground, North Adelaide, May, 1921, G. S. (McAlp., 1902, p. 104).

Phoma macrophoma, McAlp. On twigs of *Citrus aurantium*, L. Clarendon, Jan., 1921, G. S. (McAlp., 1899, p. 108).

Phyllosticta brassicicola, McAlp. "Ring spot" on outer leaves of *Brassica oleracea*, L. Upper Sturt, Jan., 1921, G. S. (Vict. Dept. Agr. Pamphlet, Cabbage and Cauliflower Diseases, 1901).

Pyrenochaete rosella, McAlp. Saprophyte on decaying almond leaves on the ground. Blackwood, May, 1921; North Adelaide, May, 1921, G.S. (McAlp., 1902, p. 97).

Septoria depressa, McAlp. On fruit of *Citrus aurantium*, L., forming circular brownish scabs. Salisbury, Sept., 1915; Campbelltown, Oct., 1921 (McAlp., 1899, p. 83).

Septoria dianthi, Desm. On living leaves of *Dianthus carophyllus*, L. Fullarton, Sept., 1918, F W. Eardley. Not listed by McAlpine.

Septoria lepidii, Desm. On living leaves of *Lepidium draba*, L. Morphett Vale, Sept , 1915. Not listed by McAlpine.

Septoria lycopersici, Speg. On stems and leaves of *Lycopersicum esculentum*, Mill. Marion, Nov., 1919; Gawler River, Dec., 1921. Not listed by McAlpine, but recorded for Victoria (C. C. Brittlebank, Journ. Agr. Vict., xvii., p. 498, 1919).

Vermicularia angustispora, McAlp. Saprophyte on decaying almond leaves on the ground, North Adelaide, May, 1921, G. S. (McAlp., 1902, p. 104).

Vermicularia circinans, Berk. On *Allium cepa*, L. Attacking the scales, and spreading occasionally to the green leaf portion of seedling onions. Longwood, Oct. 15, 1915. Not listed by McAlpine.

Vermicularia varians, Duc. "Black Dot" disease on potato haulms, Mount Gambier, Mar., 1917. On tubers, forming slightly sunken areas just under the skin, Carey Gully, Jan., 1921, G. S. (McAlp , 1911, p. 92; Osborn, 1921).

MELANCONIACEAE.

Colletotrichum schizanthi, Jens. and Stew. On stems of *Schizanthus*, sp., causing a wilt. Glen Osmond, Sept., 1916; Kensington Gardens, July, 1917. Not listed by McAlpine.

Gloeosporium ribis, (Lib.) M. & D. On leaves and canes of *Ribes grossularia*, L. (Conidial stage of *Pseudopeziza ribis*, Kleb.). Summertown, Jan., 1921, E. Leishman. Not listed by McAlpine.

HYPHOMYCETES.

Acrostalagmus cinnabarinus, Corda. Living saprophytically on decaying potato haulms, forming a reddish mould over them. Mount Gambier, April 5, 1917, T. G. B. O. Not listed by McAlpine.

Cephalothecium roseum, Corda. Developed as a saprophyte on apple leaves from Ambleside, Feb., 1921, which were kept in a moist dish. Commonly develops as a saprophyte on decaying fruit, and appears to be a facultative parasite on stored fruit when the skin is injured. Not listed by McAlpine.

Cercospora apii, Fres. On living leaves of *Pastinacea sativa*, L. (parsnip), causing a leaf spot. Mount Lofty, Sept., 1919, T. G. B. O. Not listed by McAlpine.

Cladosporium phyllophilum, McAlp. Dark olivaceous, minutely velvety layer over the diseased, wrinkled surface of peach leaves where injured by *Exoascus deformans*. Blackwood, Feb., 1921, G. S. (McAlp., 1902, p. 100).

CONIOTHECIUM CHOMATOSPORUM, Corda. On twigs of *Pyrus Malus*, L. Blackwood, Nov., 1914, R. Fowler; Mount Gambier, July, 1915; Wirrabara, Dec., 1917. Causing cankers on the bark of apples and pears. The severe scabbing of the fruit by this fungus, which occurs in South Africa and other countries, has not been recorded here (Osborn, 1918, 1921).

CONIOTHECIUM SCABRUM, McAlp. On fruit of *Citrus aurantium*, L., causing irregular, flaky, scabbed areas. Kensington Gardens, July, 1917; Enfield, Mar., 1918; Berri, June, 1922, R. Fowler (McAlp., 1899, p. 80).

FUMAGO VAGANS, Pers. On canes of *Vitis vinifera*, L., forming a black sooty coating, "fumagine." Clare, May, 1921, T. G. B. O. (McAlp., 1897, p. 38).

HARPOGRAPHIUM CORYNELIOIDES, Cke. and Mass. Causing swollen lesions on the stems of *Leptospermum scoparium*, Forst., with the short, branched, brown conidiophores projecting from them. Cleland Gully, near Mount Compass, 1921, T. G. B. O. (McAlp., 1895, No. 1997).

OIDIUM OXALIDIS, McAlp. On living leaves of *Oxalis corniculata*, L. Forest of Kuitpo, under ash trees, Dec., 1921, G. S. (McAlp., 1895, No. 2276).

STERIGMATOCYSTIS NIGRA, v. Tiegh. On ripe grapes, the skin of which had burst. Southwark, Feb., 1921, G. S. (McAlp., 1897, p. 46).

PHYCOMYCETES.

PLASMOPORA VITICOLA, (B. and C.) B. and de T. On living leaves of *Vitis vinifera*, L. McLaren Vale, Feb., 1921; Watervale, Seven Hills, Berri, and Renmark, April, 1921.

This fungus appeared first in Australia at Rutherglen, Victoria, in the season 1916-17, and in 1917-18 did considerable damage. From this locality it seems to have spread eastward into New South Wales, and finally Queensland (1920-21). Its progress westward of Rutherglen was slow, and not till 1920-21 did it appear at Mildura. From thence it passed down the Murray, appearing at Renmark, Berri, and Watervale. It was also said to occur at Angaston. The attack was a slight one, evidently resulting from infection late in the season.

This outbreak is interesting because of the example it gives of the power of dispersal of a fungus disease by windborne spores. Mildura, the seat of the nearest epidemic outbreak in the past season, lies 100 miles east of Renmark, up the Murray. There is regular traffic between the two places by motors, so that it is possible that the spores might have been conveyed by human agency or aided by down stream air currents along the river. Berri and Renmark are roughly 100 and 120 miles east of Watervale, and between the places there is no direct traffic. Neither is there any direct traffic between the Renmark area and Angaston (in which area downy mildew is reported) or McLaren Vale, roughly 130 miles south-west of Renmark. The chance that spores would be conveyed by human agency from the Renmark area to any of these places, is very slight. Yet distances of well over 100 miles are considerable to be bridged by air-borne spores of the *Plasmopara* type. This, of course, is on the assumption that it was from the Renmark area that the other South Australian grape-growing areas became infected. Unfortunately no reliable dates can be obtained of the various outbreaks. They were all reported about the same time, except the McLaren Flat outbreak in February. It is possible that Mildura was really the centre of dispersion for the spores infecting the different areas in this State, in which case the carry of the spores would be about 200 miles to 230 miles in a straight line.

No specimens of this fungus have been received during the past (1921-22) vine-growing season, although leaves from a number of different localities in which the fungus was present in 1920-21 have been examined. It seems probable that the fungus will have difficulty in establishing itself in South Australia because of the climatic conditions (Osborn, 1921).

Synchytrium taraxaci, de B. and Wor. On living leaves of *Hypochoeris glabra*, L. Exceedingly common on its host in damp areas. Victor Harbour, Aug. 27, 1917; National Park, Oct., 1918; Tea Tree Gully, Aug., 1918, T. G. B. O. (McAlp., 1895, No. 2205).

BACTERIA.

Pseudomonas juglandis, Pierce. On stems, leaves, and fruits of *Juglans regia*, L. This bacterial disease of walnuts has, during the last twenty years, spread to almost all places in the State where walnuts are grown, even to trees 10 or 12 miles from any other. It is impossible to get a marketable crop from many trees now. Not listed by McAlpine (Osborn, 1921).

Bacterium mori, B. and L. Causing angular black spots on the leaves of *Morus nigra*, L. (mulberry). Clarendon, Jan., 1921, G. S.; Mylor, Mar., 1922, T. G. B. O. Not listed by McAlpine (Osborn, 1921).

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1921—Do., do , for the year ended June 30, 1921.

DESCRIPTION OF PLATE VII.

Fig. 1. Flowering scapes of *Bulbine bulbosa*, Haw., showing concentric teleutosori of *Uromyces bulbinis*, Thuem.

Fig. 2. Two diseased and one normal inflorescence of *Neurachne alopecuroides*, R. Br., showing modifications induced by parasitism of *Ustilago Tepperi*, Ludw.

THE FLORA AND FAUNA OF NUYT'S ARCHIPELAGO AND THE INVESTIGATOR GROUP.

NO. 2.—THE MONODELPHIAN MAMMALS.

By F Wood Jones, D.Sc., F.Z.S.,
Professor of Anatomy in the University of Adelaide.

[Read August 10, 1922.]

The Franklin Island Rat.

The Franklin Island rat was first obtained during a brief visit paid to the western island by the s.s. "Conqueror" on November 23, 1920. The shore party landed shortly before noon on a very hot day, and not much life was to be seen on the island. An old female and a young male were captured a few minutes after landing by clearing out the accumulated nesting materials from the hut which has been erected upon the northern side of the western island. One or two others were seen by various members of the shore party, but no more specimens were obtained. The two animals which had been secured were skinned, but the worst possible conditions prevailed for dealing with the material, and the skins were by no means good ones. With the capture of the first pair a doubt was set at rest, for it was at once evident that they were not marsupials, as those who knew them best had confidently asserted them to be. But though it was simple enough to determine that the animal was not a marsupial, it was an altogether different matter to establish its identity among the Murines. Its most conspicuous character was that it was a house-builder, and the house-building rats were familiar in the literature of exploration into Central Australia. From the accounts of these animals, and especially from an examination of the mounted group in the South Australian Museum, it seemed most probable that the island rat was *Conilurus conditor;* and yet it obviously differed in some respects from the nest-building rat of the interior. It being impossible to proceed further with the diagnosis in the absence of type specimens, the old female was sent to Mr. Oldfield Thomas, at the British Museum. He was good enough to reply at once that the animal was not *Conilurus conditor,* but was a member of the genus *Leporillus,* and possibly was a new species. The second, and younger, specimen was therefore sent to the British Museum to aid in the establishment of the diagnosis, and subsequently the rat was described by Mr. Oldfield Thomas

(Annals and Magazine of Natural History, ser 9, vol. viii., p. 618, Dec., 1921), and named *Leporillus jonesi* When it was found that the rat was a new and interesting one it was decided to visit the island again, and to arrange for a longer stay. The journey was made on the s s "Wookata," and the party camped upon the islands from January 9 to 12, 1922. Further specimens were obtained, and observations and notes were made upon the habits of the animals. Some old and bleached skulls were picked up, and photographs were taken of typical nests. One living specimen was secured, but it died as the result of an accident after it had been a week or two in captivity in Adelaide A third short visit was paid to the western island on February 18, 1922, in the s.s. "Conqueror" On this occasion a few specimens were shot, and one was captured alive and uninjured.

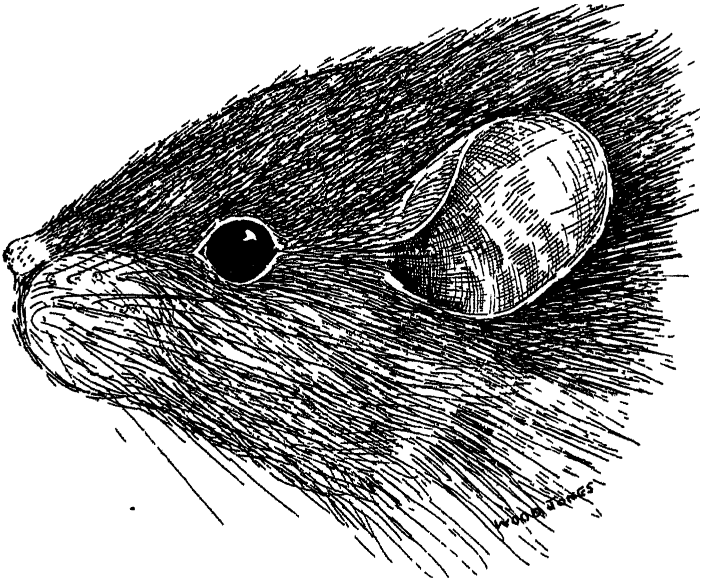

Fig. 1
Leporillus jonesi. Characters of the head from a living male adult. Natural size.

Since the animal has been described by Mr. Oldfield Thomas, and will later be dealt with by Mr. E. Troughton, of the Australian Museum, to whom specimens obtained on the second visit were sent, no attempt will be made here at further systematic description. Figs. 1 to 5 depict its most important specific characters. Mr. Oldfield Thomas' account is as follows: —

Leporillus jonesi.

"Near *apicalis*, but larger and with shorter ears. Size, as gauged by skull and foot, decidedly larger than in *apicalis*. Fur rather thin and poor, not so thick as in *apicalis;* hairs of back about 17 mm. in length. General colour, above, dull brown (not far from "Saccardo's umber"), the withers tending more towards buffy. Under surface slaty-grey broadly washed with drabby-whitish, the sides of the belly more strongly drabby. Ears shorter than in *apicalis*, dark brown. Hands with the metatarsals dark brown, the digits lighter. Feet with the ankles, outer side of the metatarsals (inner

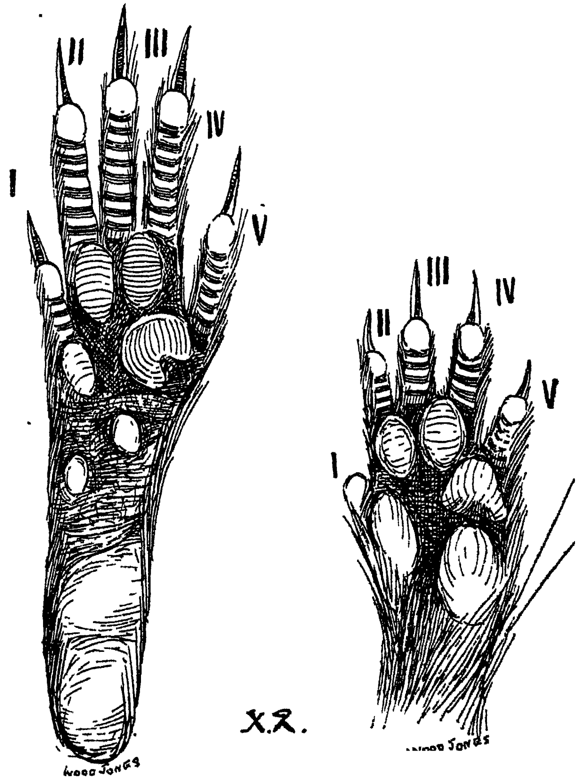

Fig. 2.
Leporillus jonesi. Left manus and pes of a female specimen. Twice natural size.

in made-up skin), and proximal parts of digits brown, the inner portion of the metatarsals and the tips of the digits white. Tail well haired but not tufted, brown above, dull whitish below, throughout its length. Not whitened at tip, as is also the case with *apicalis*, the original description notwithstanding.

"Skull larger and stouter than in *apicalis*. Muzzle broad and heavy. Interorbital region broad, with comparatively sharp-angled edges. Zygomatic plate more projected forwards. Palatal foramina short, not reaching the level of m¹. Bullae rather large—these organs not present in the available specimens of *apicalis*.

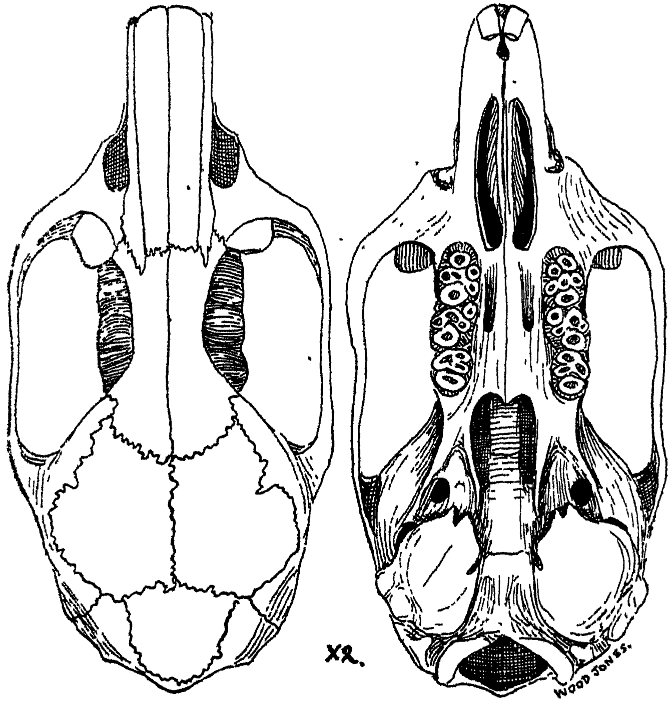

Fig. 3.
Leporillus jonesi. The skull from above and below. The specimen is from a female. Twice natural size.

"Incisors rather slender, not thicker than in *apicalis*, but meeting each other at a wider angle, owing to the greater breadth of the muzzle. Molars larger than in *apicalis*, but apparently of similar structure; much worn down in the type.

"Dimensions of the type (measured on the skin):—Head and body, 195 mm.; tail, 178 mm. (not quite perfect); hind foot, 48 mm.; ear (dry), 24 mm.

"Skull: greatest length, 48; condylo-incisive length, 46; zygomatic breadth, 23·5; nasals, 18 × 6; interorbital breadth, 5·7; breadth of brain-case, 18·5; zygomatic plate, 6; palatilar length, 13·6; palatal foramina, 8·8 × 3·8; bulla, 7·8; upper molar series, 9·3."

To this description it is only necessary to add one or two notes. The fur of the living animal is remarkable for its fluffy character, and "thin and poor," though applicable to the type skin, is not characteristic of the living animal. In a state of nature the rat has that compact and fluffy appearance that is more reminiscent of a little rabbit than of a more typical rat. It sits bunched up, so that it appears to be far broader and shorter than the prepared skin would suggest. The ears are carried well away from the head (see fig. 1), and, probably as the result of fighting, they are usually irregularly notched around their margins. The nipples are four in number, and are situated in the inguinal region. It appears that the young adhere firmly to the nipples, and for a time are dragged about by the mother; it is this circumstance which has led to a belief that the animal is a marsupial.

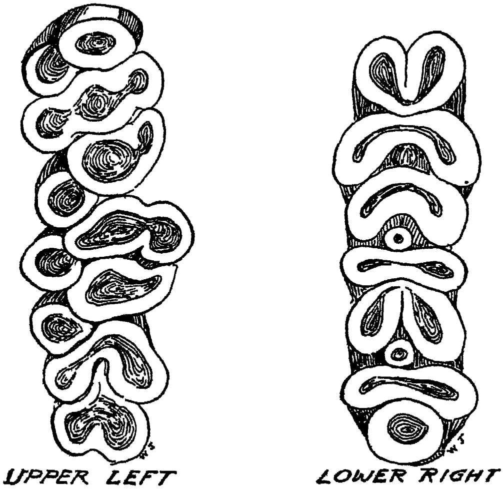

Fig. 4.
Leporillus jonesi. Crown form of the molar teeth. From a young adult female specimen. Five times natural size.

Measurements of adults, measured in the flesh, are as follow:—

	♂	♂	♀	♀	♀	♀
Rhinarium to eye	21	25	26	26	21	26
Rhinarium to ear	40	48	42	50	43	51
Ear	28	28	27	30	26	27
Tail . ..	148	162	162	173	145	155
Head and body ..	210	240	235	235	198	230
Hind foot ..	45	48	47	44	44	45
Fore foot .	19	19	20	18	19	19

In the visceral anatomy there are one or two points of interest. In the female, the clitoris is completely perforated by the urethra; and externally the two sexes are very similar in young animals.

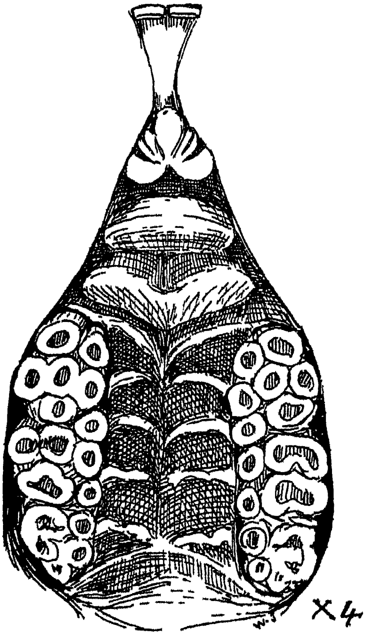

Fig. 5.
Leporillus jonesi. The palate and upper teeth to show the incisive papilla and the palate ridges.

The stomach (see fig. 6) is extremely large, and is very distinctly marked out into two chambers by a frilled edge of heaped-up epithelium. The first pouch is oesophageal in origin, and the second is the true pyloric stomach. The caecum (see fig. 7) is enormous; the caput caeci is coiled upon itself; and the whole organ occupies a very large proportion of the lower part of the abdominal cavity. In several specimens it was tenanted by a Cestode which is apparently an undescribed species. The small intestine is relatively short,

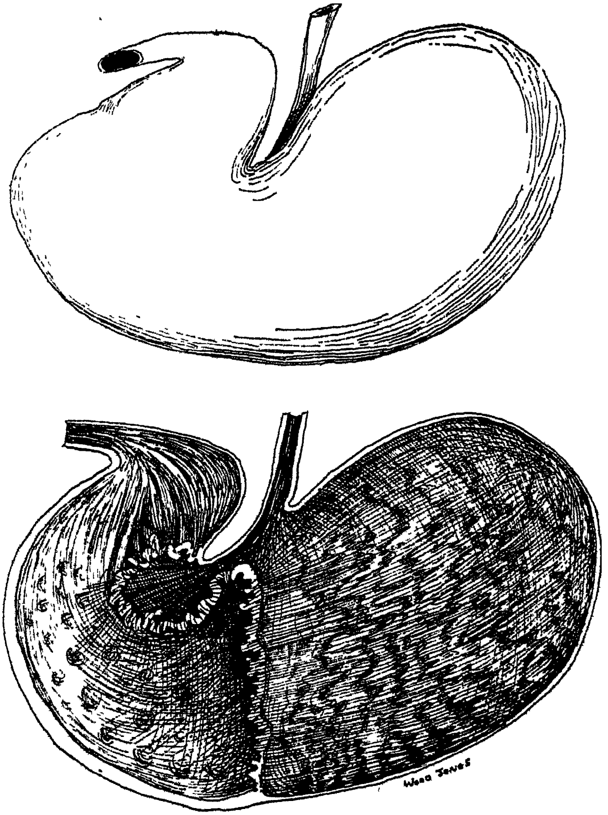

Fig. 6.
Leporillus jonesi. The stomach, showing (a) the outward form, and (b) the interior with the well-marked separation of the two chambers. Natural size.

and the large intestine, in addition to its great size, is relatively long. In *Rattus rattus* the small gut measures some

72 mm., and the large gut some 20 mm.; but in *Leporillus jonesi* the small gut is 57 mm., while the large gut measures 40 mm. The faceal pellets are more rounded in form than are those of the members of the genus *Rattus*, and they are deposited in gropus.

The rat is a nest-builder, and, so far as I have seen, never excavates burrows for itself, in captivity, it shows no desire to burrow, or even to scratch into the earth. In the islands, a burrow is almost always found beneath the nest, and into the burrow the rat will readily retreat; but the burrow is always one excavated beneath the nest by a penguin *(Eudyptula minor)* or a mutton bird *(Puffinus tenuirostris)*. There almost seems to be a measure of symbiosis in the economy of the rats and the penguins, for practically every nest which is found on the northern platform of the islands has a penguin's burrow beneath it. It is a remarkable fact that mutton birds, penguins, rats, bandicoots, and the black tiger snakes will all bolt into the same hole when alarmed.

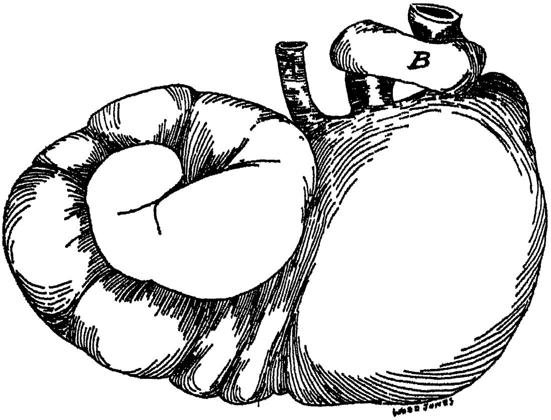

Fig. 7.
Leporillus jonesi. The caecum.
A. is the entering small intestine and B. the emerging large intestine. Natural size.

In some of the rats' nests an enormous amount of material is collected, and these large nests appear to lodge a colony. Upon the northern side of the eastern island, and high up on the cliff, is such a nest; and it is probable that its foundation consists of a deserted nest of the sea eagle, the rats having invaded it from below. Upon the flat tops of the islands, the nests are usually composed of dried herbage, and contain only a pair of individuals; but upon the island platform they are made of sticks of fresh *Mesembryanthemum*, and nearer to the sea of wrack and dried seaweed. The larger nests are complicated within, a series of passages and chambers being made in the heap of collected *débris;* but the smaller nests consist of an entrance run, a central chamber, and an exit run only. Upon the sea beaches a whisp of wrack tucked in between two boulders, or some seaweed collected in a cleft in the granite rocks suffices for a home. In any case, the nests smell badly, the lining is stained yellow, and reeks of ammonia; and all nests examined were tenanted by a beetle *(Ectroma benefica,* Newm.).

Quite a large proportion of the rat population lives upon the sea beaches, beneath and between the granite boulders which lie scattered along the shore. The staple article of diet is the succulent leaves of *Tetragona implexicoma,* and enormous quantities are consumed. It would appear that the rats also do a certain amount of scavenging along the tide line, for their footprints are always to be seen along the sand, right down to low-water mark. There is no fresh water upon the islands.

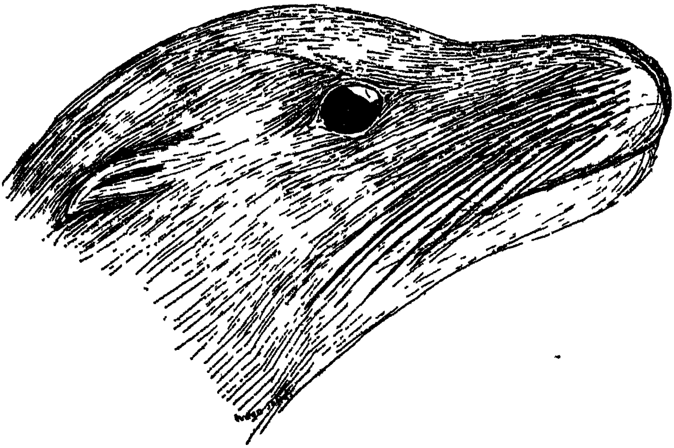

Fig. 8.
Arctocephalus forsteri. External characters of the head and face. From a young male specimen.

The breeding season is evidently in the colder months of the year, for during the time that visits have been paid to the islands (November-February) no pregnant or nursing females or very young animals have been obtained.

The rat lives upon both of the Franklin Islands, but upon no other islands yet visited. It is by no means nocturnal—most of its activities are crepuscular—but at any time of the day some individuals may be seen along the shore in the intervals between the massive granite boulders. Even in a visit at noon, on a particularly hot day, four specimens were obtained along a stretch of some 200 yards of beach. There appears to be no sort of hostility between the rats and the bandicoots (*Isoodon nauticus*) which run about and feed together, and inhabit the same territory. Indeed, as dusk comes on, it is difficult to tell which, among the many shadowy forms that appear among the low herbage of the island platform, is an *Isoodon* and which is a *Leporillus*. The rats are by no means so tame as the bandicoots, and they proved to be particularly difficult to take in traps.

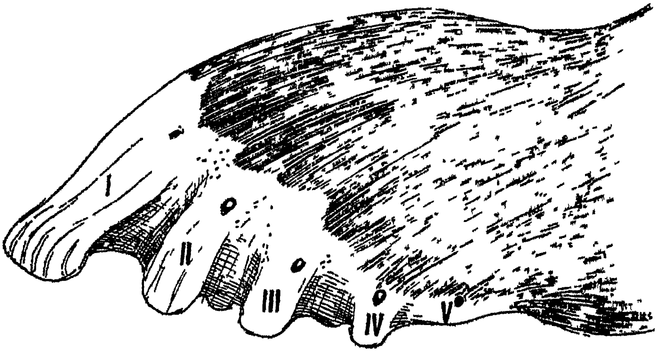

Fig. 9.

Arctocephalus forsteri. Left forelimb, young male

The fur harbours two ectoparasites, a species of flea determined by Dr. Ferguson as *Echidnophaga myrmecobii*, and a second flea "apparently indistinguishable from *Xenopsylla cheopis*." In the intestine of most specimens is a tape worm, which is being investigated by Professor Harvey Johnston.

Rats of other Islands.

Goat Island, a waterless island of the St. Francis group, is the home of a rat which is evidently abundant; but of which no specimen has so far been obtained. The footprints of the rats were to be seen round every boulder upon the sea beaches, and some skeletal remains were recovered from the pellets of birds of prey. It would seem to be a small member of the genus *Rattus*; but all efforts to obtain, or even to see, a specimen failed during the short visit paid to the island (February 11, 1922)

St Francis Island at one time possessed a rat, which is said to have been quite unlike the house or ship rat, and is described as distinctly "bluish" in colour This species has long since been exterminated on this inhabited island.

On Flinders Island is a rat of which no specimen has so far been obtained, but it is almost certainly *R. rattus*, since it is remembered that the rat was first seen in the island after a vessel had been wrecked upon the shore

Pearson Island is probably the home of two Murines, and it is hoped that these species may one day be made known to science.

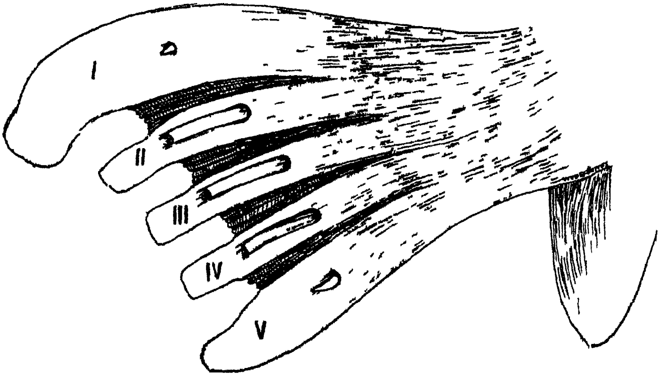

Fig. 10.

Arctocephalus forsteri. Left hindlimb, young male.

Rabbits.

Flinders Island alone possesses the unenviable distinction of having a rabbit population These animals were turned down many years ago, and for the most part they are black, or black and white in colour. It is a great pity that, with the continent of Australia as an object lesson, these animals should be tolerated on the island, which one day they will doubtless overrun

Cats.

Cats were liberated many years ago on St Francis Island. For a time they multiplied exceedingly, and have been responsible for the extermination of at least one interesting marsupial species. Of late years they have been decreasing, and it is to be hoped that the stock is a dying one.

There is no doubt the seals that inhabit the islands of South Australia are being mercilessly exterminated. A partial, but unfortunately a purely nominal, protection is extended to them; but the protection goes no further than

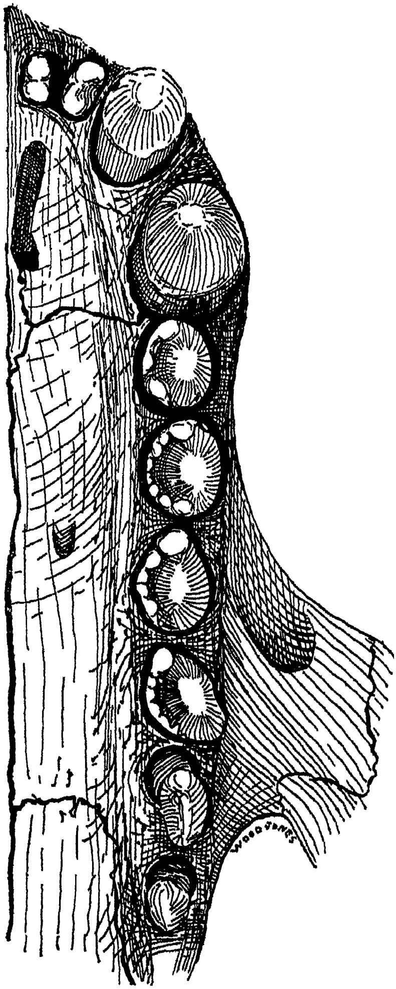

Fig. 11.
Arctocephalus forsteri. Left upper dental series of an adult. Natural size

the words printed in the Act. Upon the islands where they are "protected" they are slaughtered as freely and as barbarously as they are upon the islands where the killing is sanctioned by the law. As a matter of fact, the seals anywhere upon the islands are at the mercy of any scoundrel who cares for the revolting brutality of their slaughter, and deems the gain of a few shillings sufficient reward for the labour involved in flaying the carcass and preparing the pelt. Only one species has so far been seen on the islands.

Arctocephalus forsteri (Lesson).

The large "hair seal" may still be met with on certain of the islands in considerable numbers, and, if no sealing party has recently molested them, they exhibit a most engaging tameness, evincing a strangely persistent curiosity in the coming and going of visitors. There is no need to describe the general distinguishing characters of the species, and figs. 8, 9, and 10 sufficiently demonstrate the external characters of the head and limbs. There are six cheek teeth in the upper jaw (see fig. 11) and five in the lower. In colour there is a great variety, the variations being apparently due to age and sex; but it must also be remembered that, in judging the colour of a living seal, the degree of drying of the pelage must be taken into account. In the bulls there is constantly a lighter-coloured mane. The young pups are a rich dark brown, with the naked parts of the skin black; the eye is dark brown.

In the summer months, the seals are for the most part in little parties, with pups ranging from some 2 ft. up to nearly adult size. The voice of the old bulls is harsh and loud, and that of the pups a hissing growl rising to a sequence of pathetic yelps very much like those of a small dog. When disturbed on the islands most of the animals emit a series of long-drawn sniffs, and if the disturbance is continued the sniffs become a harsh grunting, and with that the animal gallops for the sea. Their pace on land is altogether surprising, and so is their ability to climb up the steep cliffs of some of the islands. On Price Island, especially, are well-worn tracks up the cliffs to the top of the island some 250 ft. above. On the top of the island, family parties lie basking in the sun, and the only danger that a seal is likely to prove is his desire to come down his path to the sea whilst the visitor is coming up. Apart from this, they are wholly inoffensive animals, and are deserving of all the protection that can be afforded them.

FLORA AND FAUNA OF NUYT'S ARCHIPELAGO.

NO. 3.—A SKETCH OF THE ECOLOGY OF FRANKLIN ISLANDS

By T. G. B. Osborn, D.Sc.,
Professor of Botany in the University of Adelaide.

[Read August 10, 1922.]

Plates VIII. to XI.

The following sketch of the ecology of Franklin Islands embodies the results of a brief visit paid to the group in January of this year. It had been the intention of the party to spend over four days ashore, but owing to adverse weather delaying the ship the time was reduced to two and a half; this shortage of time, and the season of the year, must explain any obvious imperfections in the account.

General.

Franklin Islands (1) form a small group consisting of two main islands with some outlying rocks and islets lying in lat. 32° 27′ S., long. 133° 39′ E., some 12 statute miles off the nearest mainland. The largest islands are each about one and a half miles in length, are flat-topped, and joined together by a sand-bar which dries at low tide. The western island is 159 ft. high and the eastern nearly the same height. A chain of rocks about one and a quarter miles in length, some of which are above water and the highest elevated about 15 ft., lies about half a mile off, and nearly parallel to the south coast of the western island. A pyramidal islet about 50 ft. high standing on a rock platform which dries at low tide extending nearly 400 yards from it, lies 1,200 yards eastward of the eastern island (pl. viii., fig. 1).

Though not, strictly speaking, a part of Nuyt's Archipelago, the Franklin Islands were sighted from it by Matthew Flinders in 1802 and were named by him. Flinders and his party did not, however, land upon them. Had they done so it is probable that Robert Brown would only have received further confirmation of his opinion as to the sterility of the islands along the central part of the south coast of Australia.(2)

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(1) Australia Directory, 10th edit., vol. i., p. 149, 1907.

(2) Brown, R., Botany of Terra Australis. Appendix to Flinders' Voyage, vol. ii., p. 534. Point Brown, one of the nearest portions of the mainland to the east of Franklin Islands, was so named by Flinders in February, 1802, in honour of Robert Brown, naturalist on board the "Investigator."

The Franklin Islands form a part of the pastoral lease of Mr. Lloyd, to whom I am indebted for information as to his impressions of their climate, etc. They are uninhabited, there being no fresh water upon them, but have been used in the past as grazing for a few sheep. Since the 1914-15 drought they have not been grazed, and at present there is little sign of disturbance owing to human occupation, even in and about the small stockyard erected near the anchorage. The islands can seldom, if ever, have been visited by a botanist before, and in their present condition it may be fairly assumed that they present a reasonably complete exhibition of their original vegetation The influence of the white man is seen in the presence of a few alien annuals, but in January these were not much in evidence.

PHYSIOGRAPHIC FEATURES.

No account of the general geology and physiography of the Nuyt's group has been published. Howchin,(3) however, has visited the islands eastward of Cape Catastrophe, and from his account it would seem that Franklin Islands are essentially similar The islands described by Howchin rest on a platform of remote age (Cambrian or Pre-Cambrian) formed of an intricate series of metamorphic, volcanic, and plutonic rocks of deep-seated origin. These old rocks lie a few feet above or below sea level and represent a base level of erosion, considered marine. On these platforms is a capping of very recent date (post-miocene) which consists of wind-blown sand, formed at a time when the sea was retreating south of the present coastline. This sand has become indurated owing to the action of rain water on its calcareous contents. "In times immediately antecedent to the present the sea returned to its old areas, and is now washing away the soft wind-constructed sandstones that were left in the line of its former retreat."

The solution of calcareous matter in the soil and its subsequent deposition, as the water evaporates, in the form of a bed of travertine limestone below the surface is a marked feature of such areas.

The Franklin Islands, so far as it was possible to observe them, agree with the type of geological formation described above. The platform of the islands is granitic, on which rests more or less consolidated sandstone. In one or two places immediately above the granitic platform a thin deposit of pebbles suggests the occurrence of a conglomerate. The cliffs at the north-west end of Eastern Franklin are decidedly more clayey than in other places, but nowhere was any superficial deposit of clay noticed as forming a compacter and more retentive soil. The surface soil is generally white sand, which is almost everywhere exposed owing to the open vegetation. The soil types may be grouped as more or less consolidated sand, travertine limestone, and white drifting sand.

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(3) Howchin, W., Proc. Roy. Geogr. Soc. S Austr., x., pp. 204-219, 1909.

The foreshore is of two types, rocky or sand The whole of the way along the south and west coasts, and along much of the east, too, the waves wash over a broad pavement of granitic rock that slopes away at a low angle to the sea, or they beat upon a jumbled mass of boulders caused by its destruction. There is thus no room for the development of a littoral flora along most of these coasts, for the consolidated sands rise from the platform of rock at a steep angle to the plateau summit. Only in a few places does the development of a wider boulder breastwork allow of the accumulation of a little sand at the cliff foot upon which littoral plants appear. On the south coast of the Western Island the cliffs rise 20 to 30 yards back from the beach, the intervening area being a level stretch of sand raised some 6 ft. above the shore line. The terrace thus formed is a curious and distinctive feature of the island, that suggests at first sight a raised beach, but which is capable of other explanation.

True dunes are developed only at the north-east end of each island, especially the western, near the sand-spit that connects the two islands. The strong south and south-west gales sweeping round the corner of the islands deposit the sand in these comparatively calm areas, building up a small but typical coastal dune of the unstable type.

The summit of the islands is a gently undulating plateau termed the "roof" in this sketch. The southern coast is highest, from whence there is a slight slope downwards towards the north, the highest point on the group (159 ft.) being a rounded knoll lying near the south-west corner.

The partly consolidated sands of the roof and cliffs of the islands are honeycombed by burrows of mutton birds or sooty petrels and penguins. The effect of their activities is to constantly disturb the sand between the larger bushes and open the way for wind erosion. The sand which is blown away is either held by vegetation on the roof forming local white dunes, or is blown to the lee-side of the island and washed away. The terrace referred to above on Western Franklin has possibly been formed by such an accumulation of wind-blown sand.

Once wind erosion starts at any point the effect is cumulative, and a "blow out" may develop, as it would in a recent sand-dune area. Several such areas can be seen in various stages upon the roof, especially upon Eastern Franklin (pl. viii., fig. 2). When the superficial layers are removed the underlying travertine is exposed as a pavement, which resists erosion. Local patches of travertine that have been exposed in this way may remain as knolls rising a few feet above the general level of the roof (pl. ix., fig. 1). Travertine pavements bear a characteristic flora that by its growth leads to their disintegration, when the sand flora reappears.

Nowhere on the islands is there anything in the nature of a watercourse, claypan, or rockhole. All rain that falls must sink directly into the soil, and presumably soaks through to the granitic platform. It might be expected that along the edge of this there would be damper areas, or even springs, but if this be so they were dry in January.

CLIMATE.

Meteorological data of uninhabited islands are obviously difficult to obtain, but some impression of the climate can be gained by comparison with the mainland nearby. The two nearest stations of the Commonwealth Meteorological Service are Fowler Bay and Streaky Bay; the records of these are given below by the courtesy of the State Meteorologist, to whom my thanks are due.

TABLE I.

Average, highest and lowest monthly rainfall at Streaky Bay (S.) and Fowler Bay (F.), in inches, for a period of 44 years:—

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average, S.	.43	.54	.59	1.02	1.97	2.86	2.36	1.94	1.36	.95	.68	.40	15.10
" F.	.38	.50	.50	.87	1.82	2.19	1.74	1.47	.94	.87	.60	.30	12.16
Highest, S.	3.37	4.67	2.43	4.05	4.81	7.51	6.02	5.12	4.03	2.37	4.18	2.48	23.50
" F.	2.94	3.90	3.26	3.74	4.31	5.76	4.30	4.82	2.62	2.67	2.79	1.43	19.00
Lowest, S.	.00	.00	.00	.00	.13	.26	.56	.43	.13	.00	.00	.00	9.34
" F.	.00	.00	.00	.00	.31	.24	.32	.36	.05	.00	.00	.00	6.91

TABLE II.

Average, absolute highest and absolute lowest temperatures, in degrees Fahrenheit, at Streaky Bay (S.) and Fowler Bay (F.), The records at Streaky Bay have been kept for 31 years, and for six years at Fowler Bay:—

	Jan	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Year
Av. temp. S.	71.7	72.6	68.5	63.9	58.9	54.8	52.9	54.9	57.8	62.5	67.0	70.5	67.2
" " F.	68.9	69.2	68.0	63.6	59.9	54.2	53.6	55.4	58.7	61.6	64.7	68.1	62.2
Abs. high, S.	114.2	114.2	104.7	96.0	88.3	79.0	73.0	83.0	91.0	104.2	113.8	117.0	117.0
" " F.	109.0	113.0	108.5	100.2	91.3	82.8	79.5	86.0	95.0	108.8	114.5	113.9	114.5
Abs. low, S.	46.2	44.8	43.5	40.2	34.0	32.0	31.2	32.2	33.9	38.0	39.5	42.5	31.2
" " F.	50.5	50.5	49.5	42.0	36.1	35.0	32.1	35.1	36.5	40.0	47.0	48.7	32.1

From the foregoing tables it is seen that the climate is of the semi-arid type,(4) though as the Franklins are islands the conditions are naturally less severe than on the mainland. Mr. Lloyd, owner of the lease, says that in his 40 years' experience on St. Francis Island (one of the Nuyt's Archipelago group) he has not known either a frost or a day of over 100° in the shade. The atmospheric humidity, also, will be greater on the islands than on the mainland. There was ample evidence that wind-shearing had an important effect on the growth form of the plants, and in killing back the exposed shoots of such relatively xerophytic plants as *Olearia axillaris* and *Calocephalus Brownii*.

As regards the rainfall (Table I.), it will be seen that the records of both mainland stations show that no rain may fall during seven months out of the year, and that the average precipitation for the four months December-March is ·50 in. or less per month.

VEGETATION.

Littoral Flora.—This may be considered under the heading of fore-cliff vegetation and coastal dunes, but except on the north coast is everywhere sparsely distributed. The main fore-cliff vegetation is *Calocephalus Brownii*, the individuals of which form low rounded bushes, 1 ft. to 2·5 ft high. The branching is densely intricate, and the linear-cylindrical leaves, 3 mm. long, stand erect, parallel to the stems. The whole plant is white in colour owing to the development of close tomentose woolly hairs. In places, along the north coast especially, and less frequently along the other coasts, such bushes form a continuous line a yard or two wide, fringing the shore, rooting in the coarse sand, and often protected on the seaward side by granite boulders. Occasionally bushes of *Myoporum insulare* and *Nitraria Schoeberi* are to be found in association with the *Calocephalus*, when the strip of vegetation is wider. Both the *Calocephalus* and *Myoporum* showed obvious wind-shearing, the twigs on the weather side being cut back and dead.

Other developments of a littoral flora, except in the case of dunes, can be considered as being rather in the nature of accidents than characteristics of the habitat. As such may be considered the occasional patches of *Frankenia pauciflora* developing at the foot of the cliffs in the sand that had lodged behind a wide zone of granite boulders. More characteristic of the littoral habitat was the development of a pure sward of *Sporobolus virginicus* just above the high-tide mark along one or two long clefts (dykes of softer rock) in the granite This was the only habitat of the plant observed upon the island.

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(4) Cannon, W. A., Plant Habits and Habitats in the Arid Portions of S. Austr., Carnegie Inst. Pub., No. 308, p. 2, 1921.

Coastal Dunes—The dune formation is of the typical South Australian type,(5) but is poorly represented, and is best seen in an active state at the north-eastern ends of the islands, as has been noted above. The first colonist is, as is usual, *Spinifex hirsutus*, which grows (though not abundantly) at the east end of Western Franklin. The strong wind action was shown by long tails of drift sand behind the Spinifex clumps The usual succession towards dune shrubland is shown, *Spinifex* being followed by *Olearia*, though no thickets develop. Together with the *Olearia* there are bushes of *Myoporum insulare*, these especially showing wind-shearing. The dune flora exhibited is of a depauperate and shifting dune type *Scaevola crassifolia*, found elsewhere on the island, does not enter into it, as is commonly the case on the mainland, while *Leucopogon Richei* and *Muehlenbeckia adpressa*—the latter very common on the mainland in the immediate vicinity—were not observed An atypical dune formation is developed fairly commonly along the north coast, and merges into the forecliff flora described above. Along this coast there is no fore-dune flora, for the sand does not blow up from the sea, but is carried across the island by the south or south-west winds, and is deposited at the foot of the slopes In one case a terrace some 20 yards across, and raised 4 to 6 ft. above the general level of the shore, has been formed. The coastal face of this falls steeply to the shore, and is a surface of erosion rather than apposition. This factor may determine the infrequency of *Spinifex hirsutus*, only found in one small patch, whereas on the normal dune it is the pioneer plant. Shrubs of the sand-dune type are represented by occasional bushes of *Olearia axillaris*, whilst, where there are more granite boulders and less sand, *Myoporum insulare*, *Nitraria*, *Calocephalus*, and *Scaevola* also come in. The greater part of this terrace is covered more or less completely by *Mesembryanthemum aequilaterale*, *Threlkeldia diffusa*, and *Enchylaena tomentosa*, which form an open association much disturbed by the burrows of mutton birds and the tracks of penguins. At one end of this area a small hut and shearing shed with sheep yard fenced by posts and wire has been erected The amount of disturbance of the vegetation caused by this is exceedingly slight. The most noticeable feature is the way that *Tetragonia* and *Enchylaena* grow as scrambling climbers over the posts an wires, so that the fence resembles a low hedge in places.

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(5) Osborn, T G. B , Brit. Assn. Rep., Australia, 1914, pp. 584-6.

Cliff Vegetation.—The word "cliff" is here used to include the various types of slope rising from the sandy beach and granite platform of the island to the roof. In most places these slopes are not steep enough to be termed cliff in the ordinary sense of the word, especially where they are sandy; but in others, where they are formed of a denser clayey material, the slope is too steep to be climbed easily. It is convenient to use the term cliff, with the reservation as above, when speaking of those sandy slopes from the roof to the shore, which are composed of consolidated sands, to distinguish them from the blown sand on which the littoral flora is developed.

It was not possible to distinguish any special associations on these areas. The flora they bear is essentially the same as that of the roof adjoining, but growing under more exposed conditions. The most frequent type of vegetation is a community with *Mesembryanthemum australe* dominant (pl. x , fig. 2). This is often a monospecific community, especially on the exposed faces of the south coast. *Mesembryanthemum australe* grows commonly on the mainland at the margins of salt swamps (in distinction to *Mesembryanthemum aequilaterale*, which is psammophilous), and its dominance on these exposed cliffs suggests that they are often wetted by spray during high winds. On faces less exposed to spray *Mesembryanthemum australe* grows with *Frankenia pauciflora*. The impression was gained that the relative proportions of these plants offered some rough idea of the degree of exposure and consequent salinity of the soil at the spot.

Salsola kali was found to be dominant, and often the only plant, on some cliff slopes where the sand was less consolidated. The cliffs of the north coast, especially on Eastern Franklin, show greater diversity of flora. It is probable that here, the exposure to spray and wind being less, the soil factor, with its consequent effect on drainage and aeration of roots, has more play. The communities observed were all open, but it was possible to recognize more than one type. On steep slopes, where the sand was mixed with some amount of clay, *Nitraria*, *Mesembryanthemum australe* and *Frankenia fruticulosa* were most abundant, *Threlkeldia*, *Enchylaena*, and *Mesembryanthemum aequilaterale* also being present. At one point a small landslide had taken place recently, and *Mesembryanthemum australe* and *Frankenia fruticulosa* were noticed as first colonists of the newly-disturbed ground.

Where the cliff face was more sandy (pl. x., fig. 1), *Scaevola*, *Myoporum*, and *Olearia* develop with *Mesembryanthemum australe*, *Threlkeldia*, and *Frankenia fruticulosa* as ground plants. It is probable that in such places *Scaevola* obtains conditions nearest to those under which it grows on the mainland. Locally it may almost be said to become dominant, but it quickly disappears where the soil is more compact.

Vegetation of the Roof.—There are three main associations to be recognized on the roof of the island, but in the limited time that was available to examine them it is difficult to describe them in other than a static sense. Their possible relation to each other as members of a succession will be discussed shortly below.

(i.) Rhagodia crassifolia, open shrubland.—This is the most stable type of association seen upon the island Low bushes of *Rhagodia crassifolia*, 1 ft. to 2 ft. high, cover considerable areas, this being almost the only species in the community (pl. xi., fig. 1). The association is an open one, with bare patches between the bushes, but it is thought that biological factors in the form of mutton birds and rats are largely responsible for this, and that, if these were removed, the covering of *Rhagodia crassifolia* would quickly be complete. The white ground seen in the foreground (fig. 1) is caused by mutton bird burrows, while in other places the Franklin Island rat *(Leporillus jonesi*, Thos.) had gnawed down portions of bushes near to the ground and used the stems to construct its house or wurlie, around other living bushes (see No. 2 of this series.)

The only other plant noted in this association was *Siloxerus tomentosus*, a small deep-rooting annual, the numerous wiry stems of which grow at first prostrate, then turn erect, and are terminated by characteristic compound capitula of yellow flowers.

The prevalent colour of the vegetation here in January was a dull grey-green.

(ii.) Frankenia fruticulosa association on travertine pavements.—Pavements of travertine or nodular limestone occur at all levels from a few feet above the shore line to high points on the roof. They all bear a characteristic flora of which *Frankenia fruticulosa* is the most typical species (pl. ix., fig. 1; pl. x., fig. 2). This is a mat-forming woody plant, which, though it sometimes forms a small tap root, also develops adventitious roots freely on the underside of its prostrate stems. The stems, except in the oldest parts, are hidden by numerous opposite linear-cylindric leaves (3 to 4 mm. long) standing erect. The leaves are almost grey owing to hairs, with only a tint of subdued green. They are also revolute, showing a pronounced groove on the under-surface. The thin wiry roots run horizontally at no great depth in the sandy soil between the limestone blocks. They have a solvent action

on the limestone, so that the upper-surface becomes etched by their growth and finally eaten through.

Two annual grasses grow in the sand-filled cracks of the limestone pavements. They are *Danthonia setacea* and *Calamagrostis filiformis*, of which the former is most abundant. At low levels near the sea *Mesembryanthemum australe* and *Tetragonia implexicoma* also occur; the latter was only seen along cliff edges, over which it scrambled.

Where the pavements are covered by sand, *Nitraria Schoeberi* develops a more or less extensive mound owing to its growth habit(6) (pl ix , fig 1). With it *Olearia axillaris*, and occasionally *Stipa teretifolia*, become associated. These plants represent a colonization of the pavement by the flora of unstable sand, owing to the *Nitraria;* they are not typical of the flora of the limestone pavement as such.

Frankenia fruticulosa is certainly the character plant of this association. It gives a most characteristic appearance to the areas, which can be distinguished from a distance by their light-grey colour (pl. xi., fig 1). The stability of the association is limited by the existence of the limestone. As this is broken up by the solvent action of the roots or rain water, the proportion of sand exposed becomes greater, leading to an increase in the number of annuals, and also such sand-collecting bushes as *Nitraria* and *Olearia*. Ultimately, therefore, the travertine pavement flora is replaced by an open shrubland passing through a phase in which the proportion of grasses is greatly increased. Such a transition was noticed on the roof of Western Franklin in a ridge of sand with limestone rubble, bearing old plants of *Frankenia fruticulosa* and much *Danthonia penicillata*, which is a perennial.

(iii.) Open association on loose sand.—At present about half the roof area is occupied by an open association in which the most prominent plants are *Salsola kali*, *Lepidium foliosum*, and tussocks of *Stipa teretifolia*, the only perennial plant constantly present (pl. ix., fig. 2). With these also occur *Bromus arenarius*, *Siloxerus tomentosus*, *Vittadinia australis*, etc. Such areas are literally honeycombed by the burrows of mutton birds or penguins, so much so that they are unpleasant to walk across, as the ground constantly caves in under-foot. The soil is, therefore, constantly disturbed, and large areas are bare, though annuals probably occur in the winter months. As our visit was paid in January no list of this therophyte flora could be made; from the fruits collected under bushes it was clear that an introduced *Hordeum* occurred, and also *Daucus brachiatus*. *Nitraria Schoeberi* plays a prominent part in this association in some places (pl. viii., fig. 2); it develops

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(6) Cannon, W. A., *l.c.*, p. 70.

dunes about itself, which, as the original bush dies away, become colonized by *Olearia axillaris* and *Frankenia pauciflora*.

Several patches, some up to half an acre in extent, were strewn with the dead stems of *Lavatera plebeja*. Professor Wood Jones says he saw thickets of this plant when he landed on the island in December, 1920. One place indicated by him as a locality in which *Lavatera* was specially dense is now an area of shifting sand (pl. xi., fig. 2). It is believed that the growth of the mallow was largely responsible for this. On sand the plant is mainly biennial, and by its dense growth would tend to kill out the ground vegetation below it. When the Lavatera dies there is nothing left to hold the soil, and, as a result, the sand drifts.

SUMMARY.

Plant Succession.—The general trend of succession can only be briefly suggested. The *Rhagodia crassifolia* shrubland is the most stable community, and probably represents the climax on the island. It is not unlikely that this association is really a subclimax, climatic factors limiting the succession, which, to judge from the mainland nearby, one would expect to reach a scrub woodland composed of mallees (*Eucalyptus* spp.) and *Melaleuca parviflora*. Though the *Rhagodia crassifolia* shrubland is regarded as a climax, no sign was seen of its spread or regeneration, rather the reverse. Biotic factors, notably the burrowing of birds, operating with the wind factor, disturb the area and tend to the development of drifting sand. Ultimately, if the present set of factors remain unchanged, the whole of the consolidated sands will be removed and the bare granite platform be left. The last stage of the Franklin Islands will be a wave-swept reef similar to that lying immediately south. This is clearly shown by the intermediate phase illustrated on the eastern islet beforementioned (pl. viii., fig. 1).

If there be little sign of regeneration of the climax there are earlier stages in succession to be seen. The clearest is the passage from the *Frankenia fruticulosa* association through a mixed low shrub and grassland with *Frankenia pauciflora* and *Danthonia penicillata* to a mixed open shrubland of *Nitraria*, *Olearia axillaris*, *Enchylaena*, *Threlkeldia*, etc., with *Stipa teretifolia* and various annuals. This association is unstable. The action of birds and wind depresses the succession to the *Stipa*, *Salsola*, *Lepidium* community described. This unstable association is apparently gradually coming to occupy most of the island. The most important sand stabilizer at present is *Nitraria Schoeberi*, which, owing to its dune-forming capacity and high salt toleration, tends to maintain a shrubland as opposed to an open community of tussock grass and annuals.

Flora.—Considering the interest of the fauna, it is rather remarkable that the flora should be so limited and without any peculiar species. A complete list of the flowering plants collected is given below. It numbers only 34 species, though owing to the season the annuals are probably incomplete. The list includes eight grasses, six composites, and five Chenopodiaceae. The complete absence of Leguminosae and Myrtaceae is surprising. The neighbouring coast has *Acacia* spp. on the dunes and mallees (*Eucalyptus* spp.) and *Melaleuca parviflora* on the consolidated sands. It is said that these plants occur on some of the neighbouring islands, which are larger. The present flora of the Franklins is probably vestigial, but there is no evidence that it included more Phanaerophytes in recent times.

Considering the flora in regard to the growth-forms, it will be noticed that there are five species of shrubs (14%), 13 species of undershrubs or perennial herbaceous plants (38%)—all chamaephytes—16 species of annuals (45%). Disregarding the percentages, which are probably misleading owing to the very small total number of species, and incompleteness of the annual (therophyte) flora, it will be seen that there are no Phanaerophytes other than Nanophanaerophytes, and that the whole classes of Hemicryptophytes and Cryptophytes are absent. This indicates the severity of the environmental factors, especially wind, as regards the absence of the first, and edaphic conditions (unstable soil) as regards the last two groups. The aridity of the environment is indicated by the relatively large number of annuals (Therophytes), which is almost certainly understated in the list.

APPENDIX.

The following is a complete list of the plants observed or collected. I am indebted to Mr. J. M. Black, who has kindly assisted in determining some of the species:—

N. = Nanophanaerophyte; Ch. = Chamaephyte;
Th. = Therophyte.

Spinifex hirsutus, Labill. Ch.
Stipa teretifolia, Steud. Ch.
Sporobolus virginicus, Kunth. Ch.
Calamagrostis filiformis, (Forst) Pilger. Th.
Danthonia penicillata, (Labill.) F. v. M. Ch.
Danthonia setacea, R. Br. Th.
Bromus arenarius, Labill. Th.

*_Hordeum_ sp. (seed only). Th.
Dianella revoluta, R. Br. Ch.
Rhagodia crassifolia, R. Br. N.
Atriplex prostratum, R. Br. Th.
Enchylaena tomentosa, R. Br. Ch.
Threlkeldia diffusa, R. Br. Ch.
Salsola kali, L. Th.
Mesembryanthemum aequilaterale, Haw. Ch.
Mesembryanthemum australe, Sol. Ch.
Tetragonia implexicoma, Hook, J. Ch.
Lepidium foliosum, Desv. Th.
*_Sisymbrium orientale_, L. Th.
Nitraria Schoeberi, L. N.
Lavatera plebeja, v. _tomentosa_, Sims. Th.
Frankenia fruticulosa, D.C. Ch.
Frankenia pauciflora, D.C. Ch.
Daucus brachiatus, Sieb. (from fruits only). Th.
Nicotiana suaveolens, Lehm. Th.
Myoporum insulare, R. Br. N.
Scaevola crassifolia, Labill. Ch.
Olearia axillaris, F. v. M. N.
Vittadinia australis, A. Rich. Th.
Siloxerus tomentosus, Wend. Th.
Calocephalus Brownii, F. v .M. N.
Gnathalium luteo-album, L. Th.
Senecio lautus, Sol. L. (a hairy form as well as the usual glabrous one). Th.
*_Sonchus asper_, All., v. _littoralis_, J. M. B. Th.

DESCRIPTION OF PLATES.

PLATE VIII.

Fig. 1. Islet off Eastern Franklin, showing the granitic platform with a small cap of consolidated sandstone at one end. The slope in the foreground is a travertine limestone pavement in process of decay. _Frankenia fruticulosa_, accompanied with _Danthonia setacea_, is being invaded by _Stipa teretifolia_, _Frankenia pauciflora_, _Threlkeldia diffusa_, etc. Large patches of _Mesembryanthemum australe_ present.

Fig. 2. Area on south coast of Eastern Franklin, showing sand drifting away from and exposing travertine pavement. The blown sand is held by _Nitraria Schoeberi_. The mounds in the foreground are formed by _Frankenia pauciflora_, which holds the sand forming mats up to 2 ft. in diameter. Beyond _Rhagodia crassifolia_ shrubland with occasional travertine pavements. In the middle distance is another "blow-out" area with _Nitraria_, _Frankenia pauciflora_, and _Salsola kali_.

An * denotes a plant not indigenous to Australia.

PLATE IX.

Fig. 1. Travertine knoll rising a few feet above general level of roof. Low plants on knoll are *Frankenia fruticulosa*, with few bushes of *Nitraria* holding sand on crest. In foreground tussocks of *Stipa teretifolia*, also *Salsola* and *Lepidium foliosum*. Several burrows of mutton birds are visible in soft sand below the knoll.

Fig. 2. General view on roof looking west from the knoll seen in previous figure. In immediate foreground *Frankenia fruticulosa* on travertine, beyond the open association on sand, *Stipa teretifolia*, *Lepidium foliosum*, and *Salsola*. This association alternates with *Rhagodia crassifolia* shrubland away to horizon.

PLATE X.

Fig. 1. Cliff vegetation on north coast Eastern Franklin. *Olearia axillaris* on left. Low bushes of *Nitraria*, *Myoporum*, *Threlkeldia*, and *Frankenia pauciflora*.

Fig. 2. Cove on south coast Western Franklin. Shows in foreground *Frankenia fruticulosa* on travertine slope which changes abruptly to *Rhagodia crassifolia* in middle distance. These two associations come to the water's-edge on the sheltered side of the cove. Facing, in background, is a cliff slope with *Mesembryanthemum australe*.

PLATE XI.

Fig. 1. *Rhagodia crassifolia* shrubland on roof of Western Franklin. A travertine ridge, with its lighter-coloured flora of *Frankenia fruticulosa*, may be seen running across the field in the middle distance.

Fig. 2. Recent blow-out exposing travertine pavement in foreground. The vegetation beyond is of the unstable type on sand. *Salsola kali* very abundant with *Stipa teretifolia* and *Lepidium foliosum*. Some bushes of *Nitraria*. The pavement in the foreground is said to have been covered with a dense thicket of *Lavatera plebeja* thirteen months before. The dead stems of this were very abundant on the loose sand. Photograph taken on north coast Western Franklin, looking east. The strait separating the two islands and the cliffs of Eastern Franklin are seen in the distance.

AN INVESTIGATION OF THE ESSENTIAL OIL FROM *EUCALYPTUS CNEORIFOLIA*, D.C. (THE "NARROW LEAF MALLEE" OF KANGAROO ISLAND.)

By PHILIP A. BERRY, B.Sc.

(Communicated by Professor E. H. Rennie, D.Sc.)

[Read August 10, 1922.]

The principal constituent of this oil is cineol, while it is well known that terpenes, aldehydes, and phenols are present. The object of this investigation was to determine the average cineol content, and the more precise nature and amount of these other bodies with which the cineol is associated.

The crude oil used in this investigation was obtained by steam distillation of fresh leaves and twigs, collected at Cygnet River, Kangaroo Island, in the beginning of January, 1920, from leaf country which had been previously cut about three years before The yield of crude oil was 1 per cent. The sample was an orange-brown colour and gave the following constants: —Specific gravity at $\frac{15}{15}$ ° C. = 0·9102; specific rotation, $(a)_D = -10{\cdot}40$; refractive index at 20° C. = 1·4707; dispersion, 0·01029. The oil was soluble in 1·33 volumes of 70 per cent. alcohol (by weight) at 20° C. The saponification number for the esters and free acids was 7·0.

Another sample of oil was distilled at Cygnet River, about the middle of May, 1921, from the same species, in a similar stage of growth, and under conditions similar to those existing in the above distillation. This oil gave the following constants: —Specific gravity at $\frac{15}{15}$ ° C. = 0·9248; specific rotation, $(a)_D = -4{\cdot}91°$; refractive index at 20° C. = 1·4670; dispersion, 0·00979. The oil was soluble in 1·05 volumes of 70 per cent. alcohol at 20° C.

This second distillation was performed to obtain an idea of the difference between the oils distilled in the summer and in the winter. The samples cannot be considered strictly comparative, however, since, in the first case, the distillation was continued until the leaf was exhausted of oil, while the second sample was distilled under ordinary commercial conditions, that is to say, until the amount of oil distilling was very small in comparison to the water, and in consequence contained less than the previous sample of the higher boiling or less volatile constituents of the leaf.

Physical Constants.—In order to save repetition and avoid ambiguity, the following explanatory note is inserted.

Specific Gravity.—The specific gravity was taken with as large a pyknometer as the amount of liquid permitted. The pyknometers were standardized with water at 15° C., and when the specific gravity was taken at another temperature, the result was calculated to $\frac{15}{15}$° C. by using a coefficient of cubical expansion of 0·00075 for each ° C. The specific gravity refers to that calculated for $\frac{15}{15}$° C., except where other temperatures are given.

Rotation.—The rotation refers to the actual rotation in a 100 mm. tube.

Refractive Index.—The refractive index was taken with an Abbé refractometer, and the result calculated for a temperature of 20° C. by adding or subtracting 0·00047 for each °C. by which the temperature exceeds or falls short of 20° C. The refractive index scale of the instrument is so arranged that it reads directly the refractive index for the mean of the D lines of sodium light.

Dispersion.—The dispersion figures given refer to the dispersion between the C and F lines of hydrogen (656·3 uu. to 486·1 uu.). The dispersions were taken at the same temperature as the refractive index, but were not calculated for 20° C., as the correction over a small range of temperature is negligible.

Temperature.—All thermometer readings have been corrected for the unimmersed portion of the stem of the thermometer.

Experimental.—The first sample of oil distilled was the one used throughout in this investigation.

A. DISTILLATIONS.

A 1.—The oil was first subjected to dry distillation. On distilling the crude oil, it commenced boiling at 80° C., and some acid, water, and volatile aldehydes distilled over first. As the oil appears to suffer decomposition by prolonged heating at a high temperature, the quantity used for distillation was 80 ccs., since this small quantity could be distilled quickly and at the same time represented the minimum required for tests. The following results are the average of four distillations:—

Temperature.	Amount.	Rotation.
Below 175·5° C.	7%	—
175·5° C.-186° C.	76%	− 7°
186° C.-207° C.	10%	−10°
207° C.-227° C.	3%	−23°

By slow distillation (4 ccs. per minute), the first fraction was found to have a dextro-rotation of 1°. This fraction contained a large quantity of aldehydes, their presence being proved by Schiff's reagent. Aldehydes were also found in quantity in the last fraction. Distillations under reduced pressure gave very similar results.

The oil was next subjected to steam distillation.

A 2.—One litre of the crude oil was steam distilled in seven hours. The distillate was collected in the following fractions:—

	Amount.	Rotation.
(a)	50 ccs.	− 7·0°
(b)	50 ccs.	− 7·2°
(c)	100 ccs.	− 7·6°
(d)	100 ccs.	− 6·3°
(e)	100 ccs.	− 6·0°
(f)	100 ccs.	− 7·1°
(g)	100 ccs.	− 7·0°
(h)	100 ccs.	− 8·4°
(i)	100 ccs.	− 8·9°
(j)	100 ccs.	−11·7°
(k)	50 ccs.	−22·8°

A 3.—Another litre of the crude oil was similarly steam distilled in seven hours and the distillate collected in the following fractions·—

	Amount.	Rotation.	Gravity.	Index.	sion.
(a)	25 ccs.	− 5·56°	—	—	—
(b)	25 ccs.	− 5·74°	0·9105	1·4690	0·01003
(c)	788 ccs.	− 6·9°	0·9047	1·4682	0·01001
(d)	78 ccs.	−12·2°	0·9210	1·4737	0·01043
(e)	42 ccs.	−26·15°	—	—	—

In the next three distillations the oil was treated with sodium hydroxide either before and/or during distillation, the object being to fix, and thus ensure as far as possible the removal of the aldehydes.

A 4.—One litre of the crude oil was shaken with 300 ccs, of a 5 per cent. sodium hydroxide solution. The oil was separated three days later and steam distilled. The distillate was collected in the following fractions:—

	Amount.	Rotation.	Specific Gravity.	Refractive Index.	Dispersion.
(a)	63 ccs.	− 5·19°	0·9263	1·4702	0·00996
(b)	786 ccs.	− 6·7°	0·9049	1·4679	0·01012
(c)	46 ccs.	− 9·85°	0·9177	1·4712	0·01060
(d)	68 ccs.	−26·18°	0·9475	1·4875	0·01204

A 5.—One litre of crude oil was shaken with 600 ccs. of a 20 per cent. sodium hydroxide solution for several days and steam distilled without separating the alkali. The distillation took about two and a half hours:—

	Amount.	Rotation.	Specific Gravity.	Refractive Index.	Dispersion.
(a)	28 ccs.	−5·21°	0·9004	1·4669	0·01009
(b)	815 ccs.	−5·19°	0·9059	1·4679	0·01011
(c)	50 ccs.	−5·64°	0·9257	1·4759	0·01037

A 6.—One litre of crude oil, stored in the dark since distillation, was shaken with 600 ccs. of a 16 per cent. sodium hydroxide solution and steam distilled in the presence of the alkali. The rotation of the oil was −7·28°. The distillate was collected in two fractions:—

	Amount.	Rotation	Specific gravity.
(a)	750 ccs.	−4·84°	0·9065
(b)	150 ccs	−4·8°	0·9144

B. Estimation of Cineol in Crude Oil.

It was found that the resorcinol method of estimating cineol gave very erroneous results with this oil. The aldehyde and other bodies present were, to a large extent, extracted by the resorcinol solution, thus giving results which were far too high. In one test, the oil which was not absorbed by the resorcinol solution had the same rotation as the crude oil itself, indicating that the resorcinol absorbed other bodies besides cineol. This is confirmed by the appreciable rotation (often as high as −2) of the cineol separated from the cineol resorcinol compound.

Phosphoric Acid Method.—In connection with the estimation of cineol by the phosphoric acid method, the writer carried out estimations on control samples, containing various proportions of pure cineol diluted with ordinary commercial turpentine.

Those samples containing about 70 per cent. cineol (by volume) gave excellent results, while 80 per cent. cineol samples were slightly low, and 60 per cent cineol and less gave very erroneous results, a 60 per cent. sample only averaging 45 per cent. cineol and a 50 per cent. one appeared to contain 30 per cent. cineol. It was observed that accurate results were only obtained when the cineol phosphate mass (before pressing) was of a powdery nature, a pasty mass of cineol phosphate invariably giving low results. A probable explanation of these low results is that the pasty condition is caused by the solvent action of the other constituents on the cineol phosphate compound. The addition compound so dissolved being removed on pressing the solid cake thus causes a low result. A pasty compound of cineol phosphate resulted on mixing the crude oil with phosphoric acid, and this pasty nature of the phosphate compound could not be overcome even by the addition of an equal volume of pure cineol to the crude oil. When, however, the crude oil was refined by steam distillation by removing from 5 to 10 per cent. of the higher boiling fractions, the cineol content estimated by this method, and calculated for the crude oil, was equal to from 60 to 63 per cent. cineol.

Even these results are certainly somewhat low, as the addition compound with phosphoric acid was still slightly pasty. From other estimations and comparisons made at the time, it was concluded that a more correct figure was from 65 to 68 per cent. cineol.

Arsenic Acid Method.—The arsenic acid method, as proposed by Turner and Holmes in America in 1914, was also tried with the same control samples as were used above, and although in some cases good results were obtained, it does not generally appear more accurate than the phosphoric acid method, when working on this oil. It furthermore has the drawback that a powdery addition compound is not obtained, and thus no indication is given as to the probable accuracy of a particular estimation.

C. The Separation of Terpenes and other Hydrocarbons unabsorbed by Resorcinol Solution.

The formation of a water soluble compound of cineol and resorcinol formed a ready and convenient method for separating cineol from the hydrocarbons in the oil. The large middle fractions of the steam distillations, consisting almost entirely of cineol and hydrocarbon bodies, were severally used for this separation. They were shaken repeatedly with a 50 per cent. resorcinol (aqueous) solution to remove the cineol. Other oxygenated bodies, such as aldehydes, etc., were also largely removed by this treatment. The oil which was not absorbed by the resorcinol solution was steam distilled, and from several estimations was found to constitute about 20 per cent. of the crude oil.

Fifteen ccs. of one of these fractions, which was not absorbed by resorcinol and which had a rotation of −13·5°, were distilled and the distillate collected in the following fractions:—

	Temperature.	Amount.	Rotation.
(a)	175° C.-176° C.	6¼ ccs.	−12·48°
(b)	176° C.-177° C.	4 ccs.	−12·98°
(c)	177° C.-195° C.	3½ ccs.	−12·98°

The greater part of the last fraction had distilled at 180° C.

Oxidation with Nitric Acid.—Several ccs. of the same fraction were oxidised with dilute nitric acid (10 per cent.). From the oxidised product two acids were separated; terephthalic acid, which was identified by its insolubility in water, alcohol, ether, benzene, etc., and by its subliming on heating; and p-toluic acid, which was soluble in alcohol and melted constantly at 179° C. The formation of these acids indicated the probable presence of cymene. The middle fraction of steam distillation A 5 was treated repeatedly with a solution of resorcinol (50 per cent.). The oil unabsorbed by resorcinol solution had a rotation of −11·2, and was shaken with a solution of sodium bisulphite (35 per cent.) to remove any aldehydes which had not been polymerised by the alkali treatment. The oil was separated and steam distilled. The specific gravity was 0·861 and the rotation −10·4°, showing that the bisulphite treatment had removed some laevo-rotatory aldehyde.

Schiff's reagent gave no immediate coloration, but a faint violet developed on standing.

The sample was distilled and collected in the following fractions:—

Temperature.	Amount.	Rotation.	Specific Gravity.	Refract. Index.
(a) 175°-178° C.	21 ccs.	− 9·38°	0·8605	1·4820
(b) 178°-181° C.	16 ccs.	−10·14°	0·8619	1·4827
(c) 181°-186° C.	1·3 ccs.	− 9·2°	—	—
(d) Residue	—	− 1·7°	—	—

On shaking the fraction marked (b) with a mixture of four volumes of concentrated sulphuric acid and one volume of water, allowing to stand for 24 hours separating, and steam distilling, and repeating the whole process until no further charring occurred, the residue so obtained had the following constants:—Rotation, +0·16°; refractive index at 20° C., 1·4936; dispersion, 0·01374. These figures closely approximate to those ascribed to cymene.

Separation of Pure Cymene.—In order to separate pure cymene, the oil unabsorbed by resorcinol solution from the middle fraction of steam distillation A 5 was treated as follows:—

It was shaken with a solution of sodium hydroxide (15 per cent.), the oil separated and steam distilled in the presence of caustic soda (digested with solid caustic soda) for several hours, then heated for half a day with sodium metal and again digested with solid caustic soda for one day. After again steam distilling in the presence of caustic soda and digesting with sodium metal and solid caustic soda several times it was again distilled. The oil distilled between the limits 172 and 181° C., but the bulk distilled from 175-178° C. The distillate had a rotation of $-3{\cdot}4°$; refractive index, 1·4814; and dispersion, 0·01294. No violet colour was formed on standing with Schiff's reagent for 20 minutes. The resulting impure cymene was shaken with four successive quantities of Beckman's chromic acid mixture and steam distilled. It was then shaken with potassium permanganate solution in the cold, steam distilled, and collected in two fractions. The first fraction had an odour strongly reminiscent of cineol, while that of the second fraction was more like cymene. This latter fraction was digested with sodium for a day, distilled and collected in two fractions:—

	Rotation.
(a) 175°-178° C.	+1·48°
(b) 178°-180° C.	−0·44°

The first fraction (a) was shaken with excess of potassium permanganate solution in the cold and steam distilled. The distillate, which had a rotation of $-0{\cdot}26°$ and a refractive index of 1·4872, was digested over sodium metal and again distilled, when it boiled constantly at 177° C.; after drying, it gave the following results on combustion:—Carbon, 88·05 per cent.; hydrogen, 10·38 per cent. Theoretical for cymene: carbon, 89·48 per cent.; hydrogen, 10·52 per cent.

A portion of the same sample on oxidation with hot potassium permanganate solution, as recommended by Wallach, yielded parahydroxy isopropyl benzoic acid, which on repeated crystallization melted at 158° C. Another separation of cymene and terpenes from steam distillation A 6 (a), by means of resorcinol solution gave a sample with a rotation of $-12{\cdot}05°$ and a specific gravity of 0·8536. After repeated digestion with sodium metal, 128 ccs. were distilled and collected as follows:—

Temperature.	Amount.	Rotation.	Specific Gravity.	Refract. Index.	Dispersion.
(a) Below 175° C.	11 ccs.	− 6·7°	0·8567	1·4777	0·01255
(b) 175°-178° C.	56 ccs.	− 9·6°	0·8552	1·4795	0·01288
(c) 178°-181° C.	26·5 ccs.	−11·6°	0·8559	1·4821	0·01343
(d) 181°-184° C.	4·5 ccs.	−10·5°	—	1·4832	0·01344

The rotation of the above fractions is almost certainly due to laevo-rotatory terpenes.

Limonene.—Although these fractions contain cymene, there is little doubt, judging from the boiling point, specific gravity, and other characteristics, that limonene is also present, and that the laevo-rotation of the above samples is due to this terpene.

Pinene.—It is also very probable that dextro-pinene is present in small quantities, as 7 per cent. of the oil distils below 175·5° C., and by shaking out with resorcinol solution, a small amount of dextro-rotatory body was obtained, with an odour characteristic of pinene. Attempts to separate the characteristic nitrosochloride were not successful, but this does not prove the absence of pinene, as it is very difficult to prepare the nitrosochloride from a high-rotation pinene.

D. ALDEHYDES.

Estimation.—The total amount of aldehydes occurring in the crude oil was estimated by shaking 20 ccs. of the oil in a cassia flask with about 150 ccs. of a 35 per cent. sodium bisulphite solution and heating on a water bath for three hours. The unabsorbed oil was brought into the neck of the flask by the addition of more bisulphite solution and the volume read off when cold. By this method, a figure of 7·5 per cent. of aldehydes was obtained. An identical value was also obtained on a sample of oil distilled in May of the following year. This would indicate that the aldehyde content does not vary appreciably with the season

Separation of the Aldehydes from the Oil.—It was found that the oil contains more than one aldehyde, and they were first separated from the higher boiling fractions of the oil by shaking the fraction with twice its volume of sodium bisulphite solution (35 per cent.). By this method, a large quantity of bisulphite addition compound was precipitated, which was filtered on the Buchner funnel. The filtrate consisted of oil and aqueous liquor, and these were separated, and the aqueous portion used to wash the solid residue in the funnel This washing was continued until no more oil appeared in the filtrate. The residue was then washed with fresh sodium bisulphite solution, followed by a washing with alcohol-ether mixture. The solid cake was dried, decomposed with hot sodium carbonate solution, and the aldehyde separated. This aldehyde is here referred to as aldehyde A.(1) On treating the liquor separated from aldehyde A (containing sodium bisulphite, sodium carbonate, etc) with caustic soda solution, a further separation of aldehyde took place. This aldehyde, called aldehyde B, was extracted with benzene, which was later evaporated off. The aqueous portion of the filtrate from the separation of the solid residue was treated with hot sodium carbonate solution, but no separation of aldehyde occurred. On the addition of caustic soda solution, however, a large amount of aldehyde separated, which was extracted with benzene, the latter being evaporated off. This constitutes aldehyde C. The oil which was not absorbed by the sodium bisulphite contains cineol, cymene, terpenes, and sesquiterpenes, and was used for the separation of the sesquiterpene. This separation of aldehydes was performed on the last fractions of steam distillations A 3 and A 4, and also on the final fractions of a steam distillation of 2 litres of the crude oil. These latter are indicated by the letters c and d in the table which follows (Table 1). The results tabulated below are calculated for 100 ccs. of oil used.

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(1) The aldehydes separated are here indicated by the letters A, B, and C, as it is later shown that they are mixtures.

TABLE 1.

Sample				Aldehyde A		Aldehyde B		Aldehyde C		Unabsorbed Oil	
No.	Distl.	Fr'ct.	Rotat.	Amt in ccs.	Rotat.	Amt. in ccs.	Rotat.	Amt. in ccs.	Rotat.	Amt in ccs.	Rotat.
a	A 3	o	—26·15	14·2	—50·0	3·9	—88·5	6·6	—79·3	50·0	—
b	A 4	d	—26·18	16·0	—53·6	2·2	—86·8	7·8	—74·3	50·0	—8·3
c	P'n'lt	imate	—24·68	13·3	—43·9	3·9	—90·0	4·8	—74·1	58·6	—15·1
d	final		—25·7	16·4	—54·9	4·5	—	3·6	—	51·5	—9.5

As the yield of the separate aldehydes was so small when working on these fractions, a quantity of the higher boiling fractions (called the residual oil) which remain in the still after refining the oil on a commercial scale was obtained from Kangaroo Island. This residual oil was obtained from *Eucalyptus cneorifolia* only.

The oil was steam distilled, and the distillate had a rotation of −27·88°. Several separations as described above were performed on this oil, and the results tabulated are calculated for 100 ccs. used.

TABLE 2.

No.	Aldehyde A		Aldehyde B		Aldehyde C		Unabsorbed Oil	
	Amount in ccs.	Rotation	Amount in ccs.	Rotation	Amount in ccs.	Rotation	Amount in ccs.	Rotation
e	16·0	—20·65	2·2	–	11·5	−60·0	38·2	—4·15
f	11·7	—15·8	0·7	–	25·0	−62·7	36·0	—2·31
g	11·4	—12·75	1·9	—99·7	27·3	—63·8	32·4	—2·55

The semicarbozone prepared from aldehyde A (Experiment g) melted constantly at 208° C. That prepared from aldehyde B (Experiment g) melted constantly at 199° C.

The various aldehyde portions separated were then examined individually.

Aldehyde A.

Aldehyde A separated from the crude oil in Experiment c (see Table 1) had the following constants:—Refractive index at 20° C. = 1·5110; dispersion, 0·01685.

As the amount of aldehyde separated from the crude oil fractions was very small, the aldehyde A from Experiments a, b, and d were mixed. These mixed aldehydes gave the following constants:—Specific gravity at 17·7° C. = 0·9724; corrected for $\frac{15}{15}$ ° C. = 0·9744; rotation, −52° refractive index at 20° C. = 1·5096; dispersion, 0·01673.

Aldehyde A separated from the residual oil (Experiment g, Table 2) gave the following constants·—Specific gravity at $\frac{15}{15}$°C. = 0·9720; corrected for $\frac{15}{15}$ ° C. = 0·9742; rotation, −12·75°; refractive index at 20° C. = 1·5203; dispersion, 0·01876

Preparation of the Oxime.—5 ccs. of the latter sample were dissolved in 10 ccs. absolute alcohol, and to the solution were added 10 ccs. of a saturated aqueous solution of hydroxylamine hydrochloride The mixture was then made alkaline with sodium carbonate solution and heated on the water bath for five hours, and then poured into cold water. The oxime should crystallize under these conditions It was found that by changing the water into which the heated mixture was poured, the crystallization of the oxime was facilitated. Although, in this instance, the water was changed several times, great difficulty was experienced in obtaining the oxime in a crystallized condition.

After crystallizing by this method and recrystallizing from alcohol, the oxime melted constantly at 57·2° C. Attempts to obtain a crystalline oxime from the aldehyde A samples having a high rotation always proved unsuccessful, as a pasty mass always resulted on pouring the heated liquor into water. A sample of this aldehyde A having a high rotation (−44°) was recombined with sodium bisulphite, filtered, well washed with alcohol-ether mixture, and decomposed with hot sodium carbonate solution. By this treatment, one-half of the aldehyde was lost, and the rotation of that separated had diminished to −14·5°. The specific gravity was 0·977. As the loss of aldehyde on recombining with sodium bisulphite seemed inordinately great experiments were performed to account for the loss, and it was found that the washing with alcoholic-ether mixture dissolved a considerable amount of the bisulphite compound. These alcohol-ether washings were evaporated to a low bulk, and decomposed with a solution of sodium carbonate. The aldehyde thus separated had a high rotation (−44°). It therefore appears highly probable that aldehyde A consists of two aldehydes, and that the bisulphite addition compound of the one with the high rotation is more soluble in alcohol-ether than the other. Another sample of aldehyde A having a rotation of $-34°$, after recombining with sodium bisulphite, filtering, washing, and decomposing with sodium carbonate, had a rotation of $-5·9°$. The oxime was also prepared from this latter sample, and it easily crystallized when poured into water. It melted constantly at 55·7° C. It was noticed that the less the rotation, the easier the preparation of the oxime became.

Conclusion.—The melting point of the oxime of cumic aldehyde is 58° C., and as the constants of the aldehyde with the small rotation are very like those of cumic aldehyde, and the melting points of the oximes are approximately the same, it appears certain that cumic aldehyde is a constituent of this oil. The other portion of this aldehyde A is probably the aldehyde which H. G. Smith previously named aromadendral. (This term has recently been extended to cover the whole of the aldehydes occurring in Eucalyptus oils.)

Aldehydes B and C.

The additive bisulphite compounds of these aldehydes were not decomposed by sodium carbonate, but were by caustic soda. Aldehyde C consists of two aldehydes, and it seems probable that aldehyde B above is a mixture (probably in different proportions) of the same two aldehydes which constitute aldehyde C. It is probable that the addition compound of these two aldehydes is very soluble, and hence while the bulk of it is soluble in the sodium bisulphite solution, a small amount is precipitated along with the cumic aldehyde and the aromadendral. The aldehyde B separated by Experiment g from the residual oil was distilled under a pressure of 30 mm. The temperature rose slowly during the distillation from 132° to 141° C. The distillate gave the following constants:—Specific gravity at $\frac{20}{15}$° C. = 0·9469; corrected to 15° C. = 0·9502, rotation, $-99·7°$; refractive index at 20° C. = 1·4899, dispersion, 0·01341.

Aldehyde C separated from the crude oil by Experiment c had a refractive index of 1·505. The aldehydes constituting aldehyde C were separated from each other by means of neutral sodium sulphite solution.

Method.—The aldehyde was shaken with a solution of crystallized sodium sulphite (35 per cent., neutralized to phenolphthalein), the liberated sodium hydroxide being continuously neutralized with normal sulphuric acid. The uncombined aldehyde was extracted by benzene. The combined aldehyde was liberated by caustic soda solution and extracted with benzene. This separation was performed on aldehyde C obtained from the residual oil by Experiment e. The aldehyde which combined with the neutral sodium sulphite, after separation by the above process and evaporation of the benzene, was distilled under reduced pressure. The bulk distilled at 121° C. at a pressure of 25 mm. and was quite colourless. The following constants were obtained:—Specific gravity at 18° C.=0·9442; corrected for 15° C.=0·9462; rotation, =−65·61°; refractive index at 20° C.=1·4834; dispersion, 0·01247.

The aldehyde which did not combine with neutral sodium sulphite, and which was extracted with benzene, was separated from the latter and distilled under reduced pressure. It did not distil at so constant a temperature as the sample above. The temperature rose from 125 to 135° C. during the distillation, while the pressure decreased from 28·5 to 20·5 mm. This aldehyde had a rotation of −70·64°, and was not oxidised by exposure in the atmosphere, the rotation remaining unaltered after exposure in an open beaker for fourteen days. This point is here stressed, as H. G. Smith,⁽²⁾ in his separation of these aldehydes from Eucalyptus oils, states that this fourth aldehyde is oxidised by the air and closely resembles the phellandral separated by Schimmel and Co. from water fennel oil. (The volatile oils, by Gildemeister and Hoffman, page 432.) The aldehyde here separated cannot be phellandral, as the latter is oxidised on exposure to the air. This separation was also performed on aldehyde C of Experiment g. The aldehyde which combined with the sodium sulphite after separation was distilled under reduced pressure; about two-thirds of it distilled at 126° C., the pressure being constant at 32 mm.; the temperature then gradually rose to 130° C. The distillate gave constants practically identical with those from Experiment e (see above).

These constants are practically the same as those obtained in the first separation and agree with those given by H. G. Smith for Cryptal.⁽³⁾ No crystalline oxime could be separated from this aldehyde.

The aldehyde which did not combine with sodium sulphite was distilled under reduced pressure and collected in two fractions:—

(a) 121°-126° C.	21 mm.	33 ccs.
(b) 136°-140° C.	32 mm.	26 ccs.

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(2) "A Research on the Eucalypts and their Essential Oils," by R. T. Baker and H. G. Smith, p. 386.

(3) *Ibid*, p. 387.

About 20 ccs. of (b) distilled between 136 and 138° C., and then the temperature rose slowly to 140° C. The following constants were obtained:—

	Sample A.	Sample B.
Specific gravity	0·9516	0·9553
Rotation	−67·92°	−72·22°
Refractive index at 20° C. ..	1·4888	1·4921
Dispersion	0·01325	0·01363

The preparation of the oxime was tried on these samples, but the product was only crystallized with great difficulty. By carefully crystallizing from chloroform, however, minute crystals were obtained; one crystal grew sufficiently to permit of its removal by mechanical means. When washed and dried it melted at 84-85·5° C. As this aldehyde is not identical with any yet separated from Eucalyptus oil, it is proposed to call it cneoral. The amount available did not permit of any extensive work being performed on it, and it is possible that it may later be proved to be identical with some aldehyde already separated from some other Eucalyptus oil.

Conclusion.—This oil appears to contain four aldehydes—cuminal, aromadendral, cryptal, and a fourth one, which is here called cneoral. The first three of these agree with the aldehydes separated by H. G. Smith *(loc. cit.)* from Eucalyptus oils.

E. SESQUITERPENE.

The last fraction in the distillation of the oil contained a sesquiterpene, which answered to H. G. Smith's tests for aromadendrene. The oil which was left unabsorbed after shaking the higher boiling fractions of the crude oil with a 35 per cent. sodium bisulphite solution (to remove aldehydes) was equivalent to 4 per cent. of the crude oil and had a rotation of −15·1°. As the quantity of sesquiterpene present was small, the residual oil left after refining the crude oil on a commercial scale was shaken with a solution of sodium bisulphite (35 per cent.). About one-third of the oil was not absorbed by this treatment, and it gave the following constants:—Specific gravity = 0·9421; rotation = −2·55°; refractive index = 1·4800; dispersion, 0·01086. This sample was shaken with a solution of resorcinol (50 per cent.) to remove the cineol, and then steam distilled. The resulting oil, which constituted 69 per cent. of the previous fraction, was practically colourless and gave the following constants:—Specific gravity = 0·9356; rotation = −2·7°; refractive index at 20° C. −1·4788; dispersion, 0·01055.

Conclusion.—This oil contains a small percentage of a sesquiterpene (not more than about 2 per cent.), which appears to be aromadendrene.

F. PHENOLS.

The crude oil contains a small amount of phenols. One litre of the crude oil was shaken with 300 ccs. of a 5 per cent. sodium hydroxide solution, and the aqueous liquor separated and shaken with ether to remove adhering oil. It was next acidified, extracted with ether, and the latter evaporated off. The residue was washed with sodium bicarbonate solution, extracted with ether and evaporated. The final yield was 2 ccs., which is equivalent to 0·2 per cent. of the crude oil. Beyond applying qualitative tests, no further work was done, owing to the small amount of material available.

G. ALTERATION OF THE SPECIFIC GRAVITY, ROTATION, REFRACTIVE INDEX OF THE CRUDE OIL ON KEEPING.

The following table gives a summary of the results obtained:—

Sample.	Rotation.	Specific Gravity.	Refract. Index	Dispersion.
1. Crude oil freshly distilled (Jan., 1920)	−9·5°	0·9102		—
2. Crude oil stored in a tightly-corked bottle in the dark for 1½ years		0·9105		
3. Crude oil stored in a loosely-corked iron drum for 1½ years	−7·3°	0·9145	1·4707	0·01029
4. Crude oil exposed to light in white glass for 1½ years ...	−4·7°	0·9311	1·4728	0·01033

Conclusion.—The specific gravity increases on keeping, while the rotation diminishes. The refractive index and the dispersion also increase. These changes are accelerated by exposure to light, and are probably caused by the polymerisation of the terpenes and/or aldehydes.

SUMMARY.

The results of this investigation have shown that the oil from the leaves and twigs of *Eucalyptus cneorifolia* distilled in January has the following approximate composition:—

Cineol		67%
Cymene		15%
Limonene		5%
Pinene		3%
Aldehydes—	Cumic Aldehyde	7·5%
	Aromadendral	
	Cryptal	
	Cneoral	
Sesquiterpene		1%
Phenols, esters, and acids		0·5%

This work has been carried out as a research subject under the David Murray Scholarship for Science, and was performed under the direction of Professor Rennie, M.A., D.Sc., to whom I wish to acknowledge my indebtedness for advice and help given. I also desire to thank Professor Osborn, D.Sc., for the botanical identification of the species. Owing to the prolonged nature of the work and the short time available to the investigator for work at the University, the main part of the research was performed in the laboratory of Messrs. A. M. Bickford & Sons, Ltd., and I desire to thank them for the facilities and material placed at my disposal. I further wish to thank Mr. J. Hendry, Ph.C., A.I.C., for the many and helpful suggestions offered throughout the work, and also Mr. E. Burgess, of Kangaroo Island, who collected the leaves, distilled and donated the oil used in this research.

ON THE ARRANGEMENT OF THE STRIATIONS OF VOLUNTARY MUSCLE FIBRES IN DOUBLE SPIRALS.

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[Read September 14, 1922.]

Plate XII.

While examining the muscles of the larvae and adults of a small parasitic wasp, *Nasonia*, I noticed, recently, that the striations were not disposed transversely, as is supposed to occur universally in voluntary muscle, but that they were arranged in the form of a double spiral. The structure of these muscles will be referred to more fully in a later paper.

The purpose of this note is to draw attention to the fact that the striations of voluntary muscle fibres, which histologists are unanimous in regarding as truly transverse, are in reality likewise disposed in the form of double spirals. I have observed this in the muscle fibres of the crayfish *Astacopsis*, in the leg muscles of a South Australian grass-hopper, and in the voluntary muscles of the much studied water-beetle *Dytiscus*.

Amongst mammals I have observed it in the muscles of the rat, the pig, the dog, the rabbit, the mouse, and, finally, in human muscle fibres, and its presence in such widely separated groups suggests its universal occurrence.

In a well-stretched fibre this double spiral arrangement of the striations is relatively easy to detect, and is shown in fig. 3, taken from the muscles of man. In such muscles it is possible to begin at one end of a fibre, and focussing up and down to travel along the spiral. Muscle fibres, however, are usually examined in the contracted condition; under these circumstances it is often extraordinarily difficult to detect the spiral nature of the striations. Two methods may, however, be adopted:—

(1) If a muscle fibre has been well flattened, the striations at the sides of the fibre may actually be observed to bend downwards and out of the plane in which the striations on the upper portion of the fibre have approximately lain. This condition, taken from a muscle in the dog's tongue, is shown in fig 4. Generally, however, the striations are so very close together that it is possible only with the greatest difficulty to notice the small change in direction taken by the turn of the spiral.

(2) A more successful way to exhibit the presence of the double spiral is to make a camera lucida drawing of the upper striations of a muscle fibre, then focussing through to the lower side make a similar drawing on a separate piece of fairly transparent paper. Accurate superposition of the two drawings will reveal the presence of a *single* spiral Care is required in the interpretation of the result. Only one-quarter of a turn of a spiral is visible in one focus of the microscope; by focussing successively, therefore, upon the upper turns and then upon the lower turns, the additional rise or drop in the spiral which would occur if the path of the spiral in the thickness of the fibre could be observed, is eliminated. The single spiral obtained by the superposition of the two drawings will therefore indicate the actual presence of a double spiral.

The objection which may be taken against this interpretation is that the change in direction of the striations in the upper and lower side of the muscle under examination is due to a shearing stress, perhaps due to the pressure of the cover-glass on the preparation. By no conceivable method of distortion, however, can transverse striations be converted into *real* spirals, and the fact that it is possible to travel along the spiral in stretched fibres by successively focussing up and down along it, eliminates this difficulty.

Moreover, it is possible, in focussing *through* a fibre suddenly to come to a focus where there is a discontinuity—very faint, but still perceptible—between the upper and lower portions of the "transverse" striation, and it is often possible (see figs. 1 and 2) to observe at one focus the crossing of striations at this point, clearly indicating their spiral nature. Neither is definitely in focus, and while it is possible to see both at once, neither can be observed sharply. This is to be noticed especially clearly at the terminations of fibres, or in those places where they are not quite flat, but where the fibre, first in focus, bends slightly out. Under these circumstances one obtains a partial view along the longitudinal axis of the fibre, and can at one focus obtain a view of a partial turn of the spiral.

It is, perhaps, necessary to add that care must be taken not to focus along the plane of contact of two superimposed fibres; without this precaution a false crossing effect might readily be obtained by the simultaneous indistinct focussing of the striations of *two* fibres.

For a clear demonstration of the double spiral the longitudinal body muscles of chalcid wasp larvae may be recommended.

Since writing the above note, I have observed a double spiral arrangement of the striation in cardiac muscle fibres.

DESCRIPTION OF PLATE XII.

Fig. 1. Voluntary Muscle Fibre from leg of Mouse, × about 500. The middle of the fibre is bent slightly downwards, and is therefore at a different focus from adjacent parts, which are approximately surface views. Unstriped areas indicate blurred focus. The gradual transition from "transverse" to "crossed" striation is clearly shown as the middle of the fibre (x) comes into focus.

Fig. 2. Muscle Fibre from leg of Mouse, × 1000. The focus is along the middle of the fibre, and clearly shows crossing of striations, being the optical effect of focussing the spirals in one plane.

Fig. 3. Human Muscle Fibre, well stretched, × 920. The fibre is observed at one single focus. The fibre has become stretched to such an extent, that it is at times possible to obtain a slightly blurred image of top and bottom of fibre simultaneously; under these circumstances the complete *double* spiral may be seen.

Fig. 4. Portion of Muscle Fibre from Tongue of Dog, × 1400. The fibre has been considerably flattened, and shows bending down of the striations at the sides of the fibre. Note especially, that the blendings are in opposite directions.

AUSTRALIAN LEPIDOPTERA OF THE GROUP GEOMETRITES.

By A. JEFFERIS TURNER, M D., F.E.S.

[Read September 14, 1922]

Hitherto I have regarded the moths here dealt with as forming a single family, the Geometridae. Recent study of the families belonging to the Noctuoidea (Caradrinina of Meyrick) has caused me to revise my opinions. The families Syntomidae, Arctiadae, Hypsidae, Nolidae, and Noctuidae, though natural and necessary, yet in the structure of their more typical and primitive genera are so closely allied, that we must reconsider the value of our family groups of other sections of the Lepidoptera. There should be a general correspondence in the structural value of family characters, though a precise equivalence is, of course, impossible. I propose, therefore, to regard the Larentiadae, etc., no longer as merely subfamilies, but as groups of family rank. This was indeed done long since by Mr. Meyrick in his British Lepidoptera where he includes them with the Notodontoidae and other families in the larger group Notodontina The weak point in this classification, it has seemed to me, is that the relationship, that binds together the geometrid families into one group, is not expressed, but is lost in the larger and looser complex. This difficulty may be avoided, and I think its avoidance is necessary for any satisfactory classification, by placing them as a distinct division, the Geometrites, in a larger group the Notodontoidea, which I conceive as corresponding generally, but not exactly, with Meyrick's Notodontina.

The first three families I have already revised in former publications, but much remains to be added to bring them to completeness at the present date. The Oenochromidae I have not yet studied in detail, and of the Boarmiadae I have published only a partial and incomplete revision. In these two families I shall merely describe a small number of new forms.

Fam. LARENTIADAE.

I give a new key to the Australian genera, in which many of the names differ from those formerly adopted. Mr. L. B. Prout informs me that it has been ascertained that the names *Cidaria*, *Larentia*, etc., of Treitschke were published earlier than *Hydriomena*, *Xanthorhoë*, etc., of Hubner. He has also helped me much by indicating the European types of some of our genera. The following list indicates the changes in name now introduced:—*Euchoeca*, Hb., becomes (1) *Cretheis*, Meyr.; (2) *Euchoeca*, Hb. *Asthena*, Hb., becomes (1) *Poecilasthena*, Warr.; (2) *Minoa*, Treit. *Scordylia*, Gn., becomes *Chaetolopha*, Warr. *Eucymatoge*, Hb., Sect. 1, 2, and 3, become *Horisme*, Hb; *Eucymatoge*, Hb.; *Eccymatoge*, Prout. *Hydriomena*, Hb., Sect. 1, and Sect 2 and 3 together become *Euphyia*, Hb., and *Cidaria*, Treit. *Xanthorhoë*, Sect. 1 and 2, become *Xanthorhoë*, Hb., and *Larentia*, Treit.

The family is a large one; the numerous genera are closely allied; and their classification is difficult. It is a group which permits of no primary division; all the characters employed for generic distinction are of secondary value. For instance, the smooth face characteristic of the *Asthena* group is found also in *Sauris*, which resembles that group in no other character, and had, I believe, a quite different origin. Again the possession of a single or double areole, though valuable, is a secondary character, which has been independently developed in many instances By its use we may separate many pairs of genera, which are as closely or more closely allied to each other than to anything else. Such pairs are: *Euchoeca*—*Minoa*, *Tephroclystis*—*Mnesiloba*, *Chaetolopha*—*Cidaria*, *Epirrhoë* (Europe)—*Euphyia*, *Asaphodes* (New Zealand)—*Xanthorhoë*, *Dasysternica*—*Dasyuris*. Although the character is a valuable one, and indeed indispensable, it is not certain that the generic distinctions thereby made will always be natural; for no reason can be given why this modification, unaccompanied by any other, may not have arisen independently in different unrelated species of the same genus. In two other generic characters, which I consider valid, even more difficulty presents itself. Of these the first is the pectination of the male antennae. This also is a secondary character, and separates groups otherwise similar or identical in structure, *Xanthorhoë* from *Euphyia*, *Larentia* from *Cidaria*, *Asaphodes* from *Epirrhoë*, *Notoreas* from *Dasyuris*, *Venusia* from *Euchoeca*. In addition to this weakness there are also intermediate conditions difficult to classify. For instance, Meyrick places the European *vittata* in *Xanthorhoë*, and this may be its natural position, but the male antennae cannot be termed pectinate. This difficulty might be got over by broadening the definition of the genus, but the Australian *percrassata* and *vacuaria* (the latter also placed by Meyrick in *Xanthorhoë*) have the same antennal structure, and closely similar is that of *strumosata*, while all three species appear to fall more naturally under *Euphyia*. These difficulties occur, however, seldom, and greater difficulties in classification would, I believe, arise if we reject antennal characters altogether.

It will be seen that some of the objections so forcibly urged by Mr. Meyrick (Trans. N. Z'd. Inst., 1916, p. 248) against the generic value of modifications of the discocellulars and origin of vein 5 of the hindwings apply also to characters which he recognizes as valid. If applied with impartial logic, they would destroy his own, and, I believe, any other possible classification of the family. It must be admitted that here also intermediate forms occur, though rarely, but they are not such as should create any real difficulty. Vein 5, which is the second median vein, arises normally opposite the termination of the upper primary branch of the median trachea, which becomes obsolete in the adult wing, but its point of termination is often traceable, often situated centrally, but often considerably nearer the radius than the cubitus. This is the structure in *Euphyia*, *Xanthorhoë*, and most of the genera of the family. The approximation of 5 to 6 is often conspicuous, but I do not attach generic importance to it, for 5 appears never to rise from *above* the termination of the upper primary branch of the media as it does in the Geometridae (*sensu stricto)*. Usually with this origin of 5 the discocellulars are straight or nearly so, but not always (see for instance *Epirrhoë sociata*, Bkh.). In many genera such as *Cidaria* and *Larentia* a striking modification occurs. In them 5 arises from well *below* the termination of the upper primary branch of the media, and there is a strong bend approximating to a right angle at its point of origin. Usually 5 is also strongly approximated to 4 at origin, but not always. In *microcyma*, for instance, it is from not much below the middle, but the discocellular is strongly bent at the usual point (not straight, as erroneously stated in my former revision). This structural division as thus understood appears clear-cut, and I have not so far met with a really doubtful case. Nor do I find that the genera defined by it are less natural than those defined by the areole or antennal pectination, when considered as a whole. It must, however, be admitted that, as Mr. Meyrick points out, difficulties occur in the New Zealand fauna. *Larentia cineraria* is extremely similar to *Xanthorhoë plumbea*, but here the similarity of grey coloration (doubtless protective) and very simple pattern is one that might well have been independently acquired, and I think we can here trust structure before appearance. The case of *X. adonis*, *L. beata*, and *L. benedicta* is more difficult. These certainly at first sight appear nearly allied, the last two, however, rather more closely than the first, which, except in colour, is very like *X. chorica*. Here also I am inclined to trust structure rather than appearance. The beautiful green coloration, rare elsewhere, is not infrequently developed in this family in New Zealand, and the pattern, although striking, is a very simple modification of that usual in this family. I admit that doubt is possible, and this doubt may be strengthened by the resemblance between *X. nephelias* and *L. sericodes*, which I have not seen. It may be that our structural character here breaks down, and that we may have to admit that our classification is so far imperfect. This I am easily prepared to do. The question to me appears to be, not whether our classification is perfect, but whether, taken as a whole, it is better (more natural), if we reject, or if we admit the generic value of the character in dispute.

Although this question cannot be decided by geographical distribution, yet that may throw some light on it. As I have been able to examine but few of the European species, I have asked Mr. L. B. Prout to give me the results of his examination of those included under *Hydriomena* and *Xanthorhoë* by Meyrick in his study of the European fauna (Trans. Ent. Soc., 1892, p. 53). Two species with the areole simple, species which Meyrick had not been able to examine, are omitted, and *vitatta* has been transferred to *Euphyia*. For the New Zealand fauna my material has been less complete, but through the kindness of Mr. A. Philpott I have been able to examine 43 species, and have included 10 more on the authority of Meyrick or Prout. I have omitted *subochraria* and *subrectaria* as Australian species, which may be natural immigrants into New Zealand, but were probably accidentally introduced, and *praefectata*, which is allied to *Venusia*. I have expressed the result in numbers and percentages:—

	European Fauna.		Australia.		New Zealand.	
Cidaria	68	42·5%	6	6·5%	0	0·0%
Larentia	17	10·6%	9	9·8%	17	32·1%
Euphyia ..	35	21·9%	64	69·6%	9	17·0%
Xanthorhoë .	40	25·0%	13	14·1%	27	50·9%

Very striking are the great development of *Cidaria* in the European fauna, its slight representation in Australia, and its absence from New Zealand; almost equally so the great development of *Euphyia* in Australia; while *Larentia* and *Xanthorhoë* are most developed in New Zealand.

KEY TO GENERA.

1.	Face smooth	2.
	Face more or less rough-scaled, usually with anterior tuft of scales	6.
2.	Posterior tibiae with terminal spurs only ...	*Sauris*
	Posterior tibiae with two pairs of spurs ..	3.

3.	Areole simple	4.
	Areole double	5.
4.	Areole small, 7, 8, 9, 10, 11 stalked	*Cretheis*
	Areole large, 11 arising from it separately	*Euchoeca*
5.	Hindwings with discocellulars bent, 5 from below middle	*Poecilasthena*
	Hindwings with 5 from above middle of cell	*Minoa*
6.	Areole absent, 7, 8, 9, 10, 11 stalked	7.
	Areole well developed	8.
7.	Forewings with 4 and 5 stalked	*Antimimistis*
	Forewings with 4 and 5 widely separate	*Symmimetis*
8.	Areole simple	9.
	Areole double	16.
9.	Abdomen crested	10.
	Abdomen without crests	12.
10.	Posterior tibiae with terminal spurs only	*Gymnoscelis*
	Posterior tibiae with two pairs of spurs	11.
11.	Forewings with 11 running into 12	*Chloroclystis*
	Forewings with 11 free	*Tephroclystia*
12.	Forewings with 11 running into 12 or absent	*Microdes*
	Forewings with 11 free	13.
13.	Posterior tibiae with terminal spurs only	*Anomocentris*
	Posterior tibiae with two pairs of spurs	14.
14.	Thorax smooth beneath	15.
	Thorax hairy beneath	*Dasysternica*
15.	Areole small, 11 stalked with 10	*Scotocyma*
	Areole large, 11 arising from it separately	*Chaetolopha*
16.	Abdomen crested	17.
	Abdomen without crests	20.
17.	Hindwings with 5 from middle of cell, in male with small tornal lobe	*Mnesiloba*
	Hindwings with 5 approximated to 4 or 6, male without tornal lobe	18.
18.	Hindwings with discocellulars angled, 5 from below middle	*Eccymatoge*
	Hindwings with discocellulars nearly straight, 5 from above middle	19.
19.	Thorax with a posterior crest	*Horisme*
	Thorax not crested	*Eucymatoge*
20.	Hindwings with discocellulars angled, 5 from below middle	21.
	Hindwings with discocellulars nearly straight, 5 from above middle, or rarely from middle of cell	24.
21.	Hindwings of male with 4 absent	*Heterochasta*
	Hindwings of male with 4 present	22.
22.	Hindwings of male with 6 absent	*Polyclysta*
	Hindwings of male with 6 present	23.
23.	Antennae in male ciliated	*Cidaria*
	Antennae in male pectinate	*Larentia*
24.	Thorax smooth beneath	25.
	Thorax hairy beneath	28.
25.	Antennae in male ciliated	26.
	Antennae in male pectinate	27.
26.	Hindwings of male with a well-defined spot or patch of androconial scales on upper side	*Melitulias*
	Hindwings of male without androconia	*Euphyia*

27. Antennae in male with two pairs of pectinations from each joint ... ... *Diploctena*
Antennae of male with one pair of pectinations from each joint ... . *Xanthorhoë*
28. Antennae in male ciliated .. .. *Dasyuris*
Antennae in male pectinate . . . . *Notoreas*

SAURIS PEROPHORA, n. sp.

πηροφορος, bearing a pouch.

♂, 30 mm. Head olive-green. Palpi 3, second joint rough-scaled above and beneath, terminal joint moderately long; olive-green, towards base whitish; terminal joint grey, extreme apex whitish. Antennae ochreous-grey. Thorax olive-green. Abdomen smooth, without tufts; grey, on dorsum greenish tinged. Legs greenish-grey; posterior tibiae in male normally developed but without spurs, tarsi elongate, first tarsal joint as long as tibiae. Forewings elongate-triangular, costa moderately arched, apex pointed, termen long, bowed, oblique, in male not incised; whitish largely suffused with green and dark fuscous, which form markings; five narrow transverse fasciae, dark fuscous in middle, green towards costa and dorsum, rather ill-defined; first subbasal, second at $\frac{1}{6}$, third at $\frac{1}{3}$; fourth from $\frac{2}{3}$ costa, somewhat dentate, consisting of several fine parallel lines, at first curved outwards, then inwards, and bent outwards to just before tornus; fifth similar from $\frac{5}{6}$ costa to tornus, containing a squarish fuscous spot above middle; a whitish dentate subterminal line following fifth fascia; a terminal series of dark-fuscous dots on veins; cilia whitish, apices partly fuscous. Hindwings and cilia grey; in male with a large basal dorsal pouch extending half-way to costa and to tornus, the dorsal edge of this pouch forming an erect concave lobe.

North Queensland: National Park (3,000 ft.), in March; one specimen at light. I might have taken more if I had not mistaken it for *S. hirudinata*, which it closely resembles in colour, size, and form. In structural characters it is altogether different and resembles *S. lichenias* rather closely, but the pouch of the hindwings is much larger, the first posterior tarsal joint proportionately longer, and the palpi more roughly scaled, with longer terminal joint.

Gen. CRETHEIS, Meyr.

Face smooth. Tongue present. Palpi short, slender, porrect. Antennae in male simple, shortly ciliated. Thorax without crests, not hairy beneath. Forewings with areole small, simple; 7, 8, 9, 10, 11 stalked from areole. Hindwings with 3 and 4 stalked or separate, 6 and 7 stalked, 12 anastomosing with cell to $\frac{3}{4}$ or beyond. Type, *C. cymatodes*, Meyr.

CRETHEIS CYMATODES, Meyr.

Euchoeca iophrica, Turn.

I am indebted to Mr. L. B. Prout for pointing out this synonymy. Hindwings with 3 and 4 stalked.

North Queensland: Cairns, Herberton. Also from New Hebrides.

CRETHEIS ATROSTRIGATA, Warr.

♂, ♀, 20-25 mm. Head pale ochreous; face ochreous-brown. Palpi whitish-ochreous. Antennae pale ochreous; ciliations in male $\frac{1}{4}$. Thorax pale ochreous. Abdomen pale ochreous with a few fuscous scales on dorsum. Legs whitish-ochreous; anterior and middle pairs pale fuscous on dorsal surface. Forewings triangular, costa straight, slightly arched towards base and apex, apex pointed, termen bowed, oblique; pale ochreous, with more or less pale-fuscous suffusion forming slender, indistinct, undulating, transverse lines; several of these lines form an obscure basal patch; a blackish discal dot beneath $\frac{2}{3}$ costa; a slender, undulating, fuscous line from mid-costa, at first outwardly curved, then oblique to dorsum before middle; this is followed by several less distinct lines, which sometimes combine to form a median fascia; subterminal and submarginal lines sometimes containing each several fuscous dots; sometimes a terminal series of fuscous dots on veins extending into cilia, but these are not always developed, cilia pale ochreous. Hindwings with 3 and 4 separate, termen strongly rounded; as forewings. Underside similar but paler and more suffused. Variable; southern examples are slightly larger than those from Herberton and lack the subterminal fuscous dots, but sometimes have a dark-fuscous tornal spot.

North Queensland: Kuranda, near Cairns, in May, Herberton in October, November, December, and January Queensland: Rockhampton, Bundaberg in July, Brisbane in December, Rosewood in April.

Gen. POECILASTHENA, Warr.

Type *P. pulchraria*, Dbld In most of its characters this approaches *Oporinia*, Hb., type *O. dilutata*, Bkh, but I do not think there is any really close relationship. *O. dilutata* differs in the peculiar structure of the areole, of which the dividing bar (vein 10) arises from the end of the cell, and the posterior extremity of the areole is prolonged to reach half-way, or nearly half-way, from cell to apex. In the latter respect it agrees with the allied genus *Operophtera*, Hb., which, however, has the areole simple. To *Poecilasthena* I refer, with one exception, all the Australian species formerly referred to *Asthena*, Hb.

Poecilasthena thalassias, Meyr.

The male of this species has a very large extrusible tuft of fuscous hairs on the underside of the apex of the abdomen. This will serve to distinguish it from *A. pulchraria; A. balioloma*, Turn., has also a smaller, stiffer, less woolly tuft in the same situation.

Poecilasthena sthenommata, n. sp.

σθενομματος, strong-eyed.

♂, ♀, 30-32 mm. Head grey, between antennae whitish; face fuscous-brown, lower edge whitish. Eyes rounded, in female rather large; in male much enlarged, so that a line drawn from one outer edge to the other is longer than the breadth of the thorax. Palpi in female small, in male minute; grey-whitish. Thorax grey mixed with whitish. Abdomen whitish with grey irroration. Legs ochreous-whitish. Forewings triangular, costa slightly arched, middle portion nearly straight, apex acute, termen bowed, oblique, subdentate; whitish with dull-greenish markings, thinly scaled; costa with numerous grey spots, which form the commencement of greenish transverse lines, more or less undulating; a basal patch of three or four close-set lines; a median white band containing two fine interrupted lines, succeeded by a dark-fuscous discal dot beneath mid-costa; beyond this is an undulating greenish fascia containing white dots on veins; terminal area whitish with two or three undulating, greenish, transverse lines; a fine fuscous terminal line interrupted on veins; cilia grey-whitish. Hindwings with termen rounded, dentate, a stronger acute tooth on vein 4; as forewings, but base whitish.

The enlarged eyes of the male is a very exceptional character.

North Queensland: Evelyn Scrub, near Herberton, in January; three specimens received from Mr. F. P. Dodd. New South Wales: Mount Gregson, Liverpool Range, in March; one female, in Coll. Lyell.

Poecilasthena xylocyma, Meyr.

New South Wales: Moruya, in October; one female specimen corresponding well with a female from Western Australia (Waroona) in May, in Coll. Lyell. Also from Victoria: Melbourne, Beaconsfield.

Poecilasthena panapala, n. sp.

παναπαλος, all-tender.

♂, 24 mm.; ♀, 28 mm. Head brownish-grey, anteriorly broadly white; face dark fuscous. Palpi whitish; terminal joint dark fuscous. Antennae dark grey, towards base whitish; ciliations in male minute. Thorax brownish-grey Abdomen grey, mixed with whitish, paired fuscous dots on dorsum of each segment. Legs fuscous; posterior pair except tarsi whitish on dorsum. Forewings triangular, costa slightly arched, apex round-pointed, termen bowed, moderately oblique; grey-whitish with numerous, fine, curved, brownish-grey, transverse lines and suffusion; a dark-fuscous discal dot beneath ⅖ costa; a slightly darker slender fascia from ⅔ costa to mid-dorsum, edged with wavy darker lines, an interrupted fuscous terminal line; cilia brownish-grey, apices paler. Hindwings with termen rounded, slightly wavy, and slightly angled on vein 4; as forewings but without discal dot. Underside grey, with obscurely darker discal dots on both wings, two obscure lines on forewing and three on hindwing towards termen.

Very near *P. xylocyma*. The best point of distinction in the female appears to be in the terminal line, which does not consist of paired dark-fuscous dots. The male has no recurved hairs on tornus of hindwings.

New South Wales: Mount Kosciusko (5,500-6,000 ft.) in January, two male specimens; Wentworth Falls, near Katoomba, in April, one female in Coll. Lyell.

Gen. MINOA, Treit.

Type *M. murinata*, Scop., from Europe. This genus comes very close to *Asthena*, Hb., type *A. candidata*, Schif., which differs in having 7, 8, 9, 10, and 11 stalked from areole. The stalking of 11 is unusual in the family and appears to be a good generic character. Only one Australian species, *M. euthecta*, Turn., has been recognized.

Gen. ANTIMIMISTIS, nov.

ἀντιμιμιστις, imitating, modelled after.

Frons with strong anterior tuft of scales. Tongue present. Palpi rather long, porrect or obliquely ascending; second joint thickened with appressed scales; terminal joint short, obtuse. Thorax with a small posterior crest. Abdomen with a series of small dorsal crests. Posterior tibiae with terminal spurs only. Forewings with 2 from ⅘, 3 from near angle, 4 and 5 long-stalked from angle, 6 from upper angle, areole absent, 7, 8, 9, 11 stalked from before angle, 10 absent, 11 running into 12. Hindwings with 2 from ⅔, 3 and 4 separate but approximated at origin, 5 from middle of cell, 6 and 7 stalked, 8 anastomising with cell to ⅘.

Certainly one of the *Gymnoscelis* group, and probably directly connected with *Symmimetis*, but in all other

Geometrites vein 5 of forewings arises from the middle, or above the middle of cell, with the exception of *Microdes*, in which it arises from below the middle, apparently in consequence of the development of some secondary sexual characters in the male. The stalking of 4 and 5 is an extraordinary anomaly in this family; possibly the discovery of the male may suggest some explanation.

ANTIMIMISTIS ILLAUDATA, n. sp

illaudatus, obscure.

♀, 20-22 mm. Head grey. Palpi 1½; whitish-ochreous sometimes greenish tinged. Antennae grey. Thorax grey. Abdomen grey; dorsum of second segment pale greenish-ochreous. Legs grey; anterior pair fuscous with whitish annulations on tarsi. Forewings triangular, costa nearly straight, gently arched towards apex, apex rounded, termen bowed, oblique; fuscous-grey with obscure whitish lines; first from ⅓ costa to ⅓ dorsum, indistinct, wavy; second from ⅔ costa to ⅔ dorsum, slender, outwardly bowed, irregularly dentate, a fine parallel fuscous line succeeds this, and then a pale suffused line; a fine dentate subterminal line; cilia fuscous-grey. Hindwings with termen rounded, wavy; as forewings. Underside similar but more suffused

North Queensland: Kuranda, near Cairns, in November and April; two specimens received from Mr F. P. Dodd.

SYMMIMETIS MUSCOSA, Turn.

North Queensland: Kuranda, near Cairns, in October; Evelyn Scrub, near Herberton, in December. Queensland: Brisbane, in April.

SYMMIMETIS SYLVATICA, n. sp.

sylvaticus, of the woods.

♂, ♀, 18-21 mm. Head fuscous. Palpi fuscous, towards base ochreous-whitish. Antennae fuscous; ciliations in male 2½. Thorax grey mixed with fuscous. Abdomen pale greenish-ochreous with some fuscous scales; tuft in male whitish. Legs whitish-ochreous; anterior pair fuscous with whitish-ochreous annulations on tibiae and tarsi. Forewings broadly triangular, costa gently arched, apex rounded, termen bowed, oblique; whitish-ochreous suffused with fuscous, which forms indistinct markings; a large fuscous basal patch; a dark-fuscous discal dot at ⅓ on end of cell, and near posterior edge of basal patch; immediately following this a broad, dentate, transverse, whitish-ochreous line, indistinct towards dorsum; a broad median fuscous fascia containing some blackish scales on veins, defined posteriorly by a fine, whitish, crenate line from ⅔ costa to ¾ dorsum, bent outwards in disc; a fine fuscous parallel line follows this, then a suffused whitish-ochreous fascia; a fuscous terminal band containing a fine, dentate, whitish subterminal line; a terminal series of whitish-ochreous dots on veins; cilia pale fuscous barred with whitish-ochreous opposite veins. Hindwings with termen rounded, slightly wavy; pale greenish-ochreous with patchy brownish irroration and a few blackish scales; a blackish discal dot at ⅓; cilia whitish-ochreous. Underside whitish with fuscous discal dots, subbasal, median, postmedian, and terminal fuscous fasciae, postmedian of forewing, angled outwards in middle.

North Queensland: Evelyn Scrub, near Herberton, in December, January, and February; eight specimens received from Mr. F. P. Dodd.

GYMNOSCELIS LOPHOPUS, Turn.

Gymnoscelis homogona, Turn., is a synonym.

North Queensland: Cairns, Herberton, Townsville. Queensland: Brisbane. Not uncommon in the last locality. New South Wales: Lismore.

GYMNOSCELIS SUBRUFATA, Warr.

Forewings with 11 free.

Queensland: Duaringa, Brisbane, in February; one specimen taken at rest on a gate.

GYMNOSCELIS TANAOPTILA, Turn.

I have received a female example from Kuranda in November like male but smaller (18 mm.); posterior tibiae with terminal spurs only.

GYMNOSCELIS ACIDNA, Turn.

Forewings with 11 running into 12.

North Queensland: Cairns, Townsville.

GYMNOSCELIS SPODIAS, n. sp.

ϛποδος, ashes.

♂, ♀, 13-16 mm. Head whitish; sides of face and palpi dark fuscous. Antennae grey, towards base whitish; ciliations in male ½. Thorax and abdomen grey-whitish. Legs whitish; anterior pair mostly fuscous with whitish tarsal annulations. Forewings triangular, costa gently arched, apex rounded, termen bowed, oblique; 11 anastomising with 12; whitish with grey-whitish suffusion and obscure markings;

very faintly marked whitish transverse lines, subbasal, antemedian outwardly bowed, postmedian outwardly bowed, double, subterminal sometimes dentate; a few scattered blackish scales; blackish spots on costa near base, ¼, ⅜, middle, and ⅞, that on middle larger, a blackish spot in disc beneath second costal spot following subbasal line; a large blackish spot beneath mid-costa preceding postmedian line; cilia grey-whitish Hindwings obtusely incised on vein 5, and with a rounded prominence on vein 4; as forewings but with one blackish spot preceding postmedian line, which forms a rounded projection in middle. Underside whitish partly suffused with grey.

Near *G. acidnias*, but much paler, lines much more obscure, except where partly defined by blackish spots.

North Queensland: Evelyn Scrub, near Herberton, in December, Atherton Queensland: Montville (1,500 ft.), near Nambour, in March. New South Wales: Stanwell Park, in April (Lyell). Four specimens.

GYMNOSCELIS KENNII, n. sp.

♀, 16 mm. Head brown; face and palpi blackish. Antennae pale brown. Thorax brown Abdomen brown, dorsum suffused with blackish except towards base; tuft brown. Legs pale brown. Forewings triangular, costa nearly straight, towards apex arched, apex rounded, termen slightly bowed, crenulate, strongly oblique, 11 running into 12; pale brown; markings and a few scattered scales blackish; a costal streak from base to beyond middle; a line from ⅓ costa, bent inwards beneath costa, thence strongly oblique to near base of dorsum; a second line from ⅔ costa, at first outwardly oblique, strongly bent inwards on vein 6, forming a second prominence on vein 4, bent outwards a third time above dorsum, ending on ¾ dorsum, a broad dark-fuscous suffusion from beneath costa beyond second line, broadening to fill whole tornal area; cilia brownish barred with blackish on crenulations. Hindwings with termen slightly rounded, wavy; pale brown densely suffused with dark fuscous beyond second line; three blackish transverse lines, first subbasal, second at ⅓, third at ⅔ bent outwards beneath costa and again in middle; cilia brownish mixed with dark fuscous. Underside brownish suffused with fuscous without distinct markings.

Exceptionally distinct. The broad dark-fuscous suffusion of hindwings at once distinguishes it.

Queensland: Gayndah, in October; one specimen received from Dr. Hamilton Kenny, an ardent naturalist and a personal friend, to whom I dedicate it.

GYMNOSCELIS HOLOCAPNA, n. sp.

ὁλοκαπνος, wholly smoky.

♂, 17-18 mm. Head fuscous. Palpi scarcely over 1; dark fuscous mixed with whitish-ochreous. Antennae grey; ciliations in male minute. Thorax and abdomen fuscous-brown. Legs whitish-ochreous; anterior pair fuscous anteriorly. Forewings rather narrowly triangular, costa gently arched, apex rounded; termen bowed, oblique; 11 running into 12; fuscous-brown or pale fuscous, markings obscurely darker; a basal patch; a moderate fascia at $\frac{1}{4}$, angled inwards beneath costa; a line from $\frac{2}{3}$ costa, at first outwardly bowed, then slightly sinuate to $\frac{2}{3}$ dorsum; a very obscure pale dentate subterminal line preceded by darker shading; cilia with basal half fuscous barred with whitish-ochreous opposite veins, terminal half grey. Hindwings rather narrow, termen strongly and evenly rounded: colour and cilia as forewings, but markings even more obscure; postmedian line with a median tooth, indented below middle; subterminal line strongly dentate; some blackish irroration on dorsum. Underside fuscous-whitish.

An obscure species.

Northern Territory: Darwin, in September, December, and March; four specimens received from Mr F. P. Dodd.

CHLOROCLYSTIS PHOENOCHYTA, n. sp

φοινοχυτος. suffused with reddish.

♀, 15 mm. Head whitish; face pale red. Palpi 2; grey. Antennae with joints expanded at apices; grey. Thorax whitish with a fine, transverse, postmedian line of dark-fuscous and reddish scales. [Abdomen and legs broken off.] Forewings elongate-triangular, costa slightly arched, apex round-pointed, termen bowed, oblique; 11 running into 12; whitish partly suffused with grey and reddish; costal edge reddish with some whitish strigulae; a broad, subbasal, grey fascia; its anterior edge outwardly curved, irregular; its posterior edge from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum, forming a rather large posterior tooth beneath costa, beneath this obtusely indented; median area paler with indications of a suffused grey median line; a grey line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, strongly outwardly curved, slightly dentate; this is followed by a fine, parallel, dentate, grey line; disc beyond this suffused with pale red; a whitish, dentate, subterminal line; an interrupted grey terminal line; cilia pale reddish mixed with grey, apices grey-whitish. Hindwings with termen rounded; wholly suffused with pale red except extreme base; some few dark-fuscous scales on veins; a pale transverse line at ⅓; another, broader, at ⅔ containing a very fine reddish line; subterminal indistinct, but preceded by grey dentations; cilia pale reddish, apices grey-whitish.

This species is very distinct by the red suffusion, but, the posterior legs being absent, it is not possible to be sure that it is not a *Gymnoscelis*, Type in Coll. Lyell.

Northern Queensland: Gordonvale, near Cairns; one specimen.

CHLOROCLYSTIS EURYLOPHA, n. sp.

εὐρυλοφος, broadly crested.

♂, ♀, 15-16 mm. Head pale grey. Palpi 2¼; pale grey with a few darker scales. Antennae whitish-grey. Thorax and abdomen grey. Legs ochreous-whitish; anterior pair mostly grey; outer median spur ½. Forewings triangular, costa rather strongly arched, apex round-pointed, termen bowed, oblique; pale grey with numerous, wavy, fuscous, transverse lines more or less distinct; costa of male with a crest of long hairs extending from near base to middle; transverse lines in basal half of wing sometimes very indistinct, but sometimes as many as six can be distinguished, all outwardly curved; a more distinct line from ⅗ costa, at first outwardly oblique, forming two short, obtuse, posterior projections; then inwardly oblique to ⅔ dorsum; several paler indistinct lines follow this; an obscure, pale, dentate, subterminal line; a fuscous terminal line, interrupted on veins; cilia pale grey. Hindwings with termen scarcely rounded, irregularly waved; as forewings.

This little species requires careful discrimination. The male may be distinguished readily from *C. epilopha* by the much wider extent of the crest on costal margin of forewing. Between the female of these two species it is hard to give any distinction, but the presence of blackish scales on the veins in the basal part of forewing in *epilopha* is helpful. The female also somewhat resembles *C. insigillata*, but the rounded and not waved termen of the hindwing in the latter is in itself sufficient difference.

Queensland: Montville, near Nambour, in March; seven specimens (one male, six females).

CHLOROCLYSTIS PYRSODONTA, n. sp.

πυρσοδοντος, with reddish tooth.

♂, ♀, 15-16 mm. Head fuscous. Palpi 1½; whitish-ochreous mixed with blackish towards base. Antennae grey; ciliations in male minute. Thorax pale grey, anterior edge fuscous. Abdomen pale grey. Legs fuscous; posterior pair paler; outer spurs about ⅓ of inner spurs. Forewings broadly triangular, costa gently arched, apex rounded, termen bowed, oblique; whitish, markings extremely pale grey, except in costal ¼, where they are fuscous and distinct; a fuscous costal streak from base to first fascia; first fascia at ⅓, moderately broad, sharply angled inwards beneath costa; second fascia median, similar to first, like it sharply angled inwards beneath costa; third fascia beyond ¾, narrower except on costa, evenly curved, posteriorly limited by a finely dentate, whitish, subterminal line; a fine fuscous terminal line interrupted on veins; cilia grey, apices paler Hindwings with termen unevenly rounded; concave above middle, prominent between veins 3 and 4; as forewings; but median fascia reddish with a few blackish scales, and a strong, obtuse, median, posterior tooth; without dark costal markings. Underside pale fuscous, with a darker, posteriorly toothed, median, transverse fascia on hindwings.

Northern Queensland: Cardwell, one wasted female, in August, Evelyn Scrub, near Herberton, male type, in January (F. P. Dodd)

CHLOROCLYSTIS NIGRILINEATA, Warr

♂, ♀, 18 mm. Head whitish-grey. Palpi about 1; whitish-grey mixed with blackish. Antennae whitish-grey. Thorax whitish-grey. Abdomen whitish-grey with some inconstant dark-fuscous markings. Legs ochreous-whitish; anterior pair grey. Forewings triangular, moderately broad, costa slightly arched, apex round-pointed, termen bowed, oblique; 11 running into 12; whitish-grey with pale-grey and dark-fuscous transverse lines; a dark-fuscous subbasal line with median posterior tooth; a dark-fuscous wavy line from ⅓ costa to ⅕ dorsum; a pale-grey median line, sometimes double; a dark-fuscous line from costa before ⅔, with two obtuse posterior teeth, subcostal and median, thence oblique and slightly dentate to ⅔ dorsum; a very faint, pale, dentate subterminal line preceded by an interrupted dark-fuscous line; a terminal series of interneural fuscous dots; cilia pale grey. Hindwings with termen rounded; as forewings but all lines indistinct except postmedian, which has a posterior angular projection about middle. Underside pale grey, darker towards termen, with fuscous postmedian lines on both wings.

My examples agree well with Warren's description. The dark transverse lines are conspicuous.

Northern Territory: Darwin, in November and February; two specimens received from Mr. F. P. Dodd. Queensland: Duaringa (Warren).

CHLOROCLYSTIS POLIOPHRICA, n. sp.

πολιοφρικος, grey-rippled.

♂, ♀, 13-16 mm. Head whitish. Palpi whitish, in male annulated, in female irrorated with dark fuscous. Antennae whitish, towards apex tinged with grey; ciliations in male minute Thorax pale fuscous; patagia whitish. Abdomen whitish with some fuscous scales. Legs whitish; anterior pair fuscous; posterior tibiae with inner spurs long, outer spurs ⅓, outer median spur absent in male. Forewings in male with costa straight in basal half, strongly arched in apical half, in female evenly arched throughout, apex rounded, termen bowed, oblique; whitish with fuscous markings; basal ⅔ of costa more or less suffused; a number of indistinct transverse lines preceding postmedian, in male obsolete towards dorsum; postmedian line from ⅔ costa, at first outwardly oblique, forming two angular posterior projections in disc, thence inwardly oblique to ⅔ dorsum; a fuscous subterminal line, in male thickened into spots beneath costa, above middle, and below middle, interrupted between spots, in female more uniform; an interrupted terminal line; cilia whitish, in male with some obscure fuscous bars. Hindwings with termen gently rounded, slightly wavy; as forewings; postmedian line with an angular indentation above middle, and an angular projection in middle. Underside fuscous-whitish.

Queensland: Dulong, near Nambour, in December, one female; Brisbane, in April, one male type.

Gen. MICRODES, Gn.

This genus has two remarkable peculiarities in the neuration of the forewing. One is the approximation of vein 5 at its origin to 4. This is probably secondary to the peculiar sexual modification in the forewing of the male. The other is that 11 runs into 12 in *villosata* and *asystata*, but has secondarily disappeared altogether in *squamulata*, *diplodonta*, and *oriochares*; *typhopha* and *melanocausta* I have not examined.

MICRODES ORIOCHARES, n. sp.

ὀρειοχαρης, rejoicing in the mountains.

♂, ♀, 18-20 mm. Head dark fuscous. Palpi in male 4, in female 4½; dark fuscous. Antennae fuscous; in male thickened and slightly laminate, ciliations ¼. Legs fuscous; anterior pair dark fuscous; anterior and middle tarsi with ochreous-whitish annulations. Forewings with costa moderately and evenly arched, apex round-pointed, termen bowed, moderately oblique; fuscous; a slender, obscure, outwardly curved, transverse line at ¼ followed by a pale, indistinctly double line; beyond this is a brownish-tinged fascia, not always developed; beyond this a paler area containing two or three very obscure, slender, transverse lines; a whitish line edged posteriorly by a dark fuscous line from ⅔ costa, at first moderately outwardly oblique, acutely angled outwards above middle, thence concave to below middle, where it is again angled outwards, thence straight to ⅘ dorsum; a slight brownish suffusion on posterior edge of this line; a fine, irregularly dentate, whitish, subterminal line, cilia fuscous, sometimes very obscurely barred, apices grey. Hindwings with termen strongly rounded, slightly wavy; pale grey; an obscure darker line at ⅘; cilia pale grey.

Certainly near *M. diplodonta*, Turn., but smaller, forewings proportionately broader, less brownish, costa less strongly arched, cilia not distinctly barred, palpi in male rather longer. Unless intermediate forms are discovered it should be regarded as a distinct species.

New South Wales: Mount Kosciusko, in January, February, and March; seven specimens. Victoria: Mount St. Bernard (5,000 ft.), in February; a large female (24 mm.) in Coll. Lyell.

MICRODES ASYSTATA, n. sp.

ἀσυστατος, inconstant.

♀, 26-30 mm. Head, thorax, and abdomen fuscous with scanty whitish irroration. Palpi 3½; second joint expanded by rough scales above and beneath; terminal joint short; fuscous irrorated with whitish. Antennae fuscous. Legs fuscous; tarsi with fine whitish annulations; posterior pair ochreous-whitish. Forewings triangular, costa gently arched, apex round-pointed, termen straight, very slightly oblique; whitish irrorated with grey; numerous fine transverse fuscous lines more or less distinct; sometimes stronger lines define median area; first from ⅓ costa to ⅓ dorsum, outwardly curved; second from ⅔ costa to tornus, with a small acute posterior tooth beneath costa, and an obtuse tooth beneath middle; sometimes median area is partly or wholly fuscous, and lines indistinct; a finely dentate, whitish, subterminal line; cilia grey. Hindwings with termen strongly but unevenly rounded, projecting slightly on veins 3 and 6; grey; cilia grey.

Male unknown and female inconstant; in one example the anterior margin of median band is much more strongly rounded posteriorly, an unusual form of variation. Type in Coll. Goldfinch.

New South Wales: Mount Kosciusko, in February; three specimens.

Gen. SCOTOCYMA, Turn.

This comes near the European genus *Epirrhoë*, Hb., but differs in 7, 8, 9, 10, and 11 arising by a common stalk from the small areole.

SCOTOCYMA ALBINOTATA, Wlk.

Mr. Prout informs me that *Paragramma mimula*, Warr., is a synonym.

SCOTOCYMA IDIOSCHEMA, n. sp.

ἰδιοσχημος, of peculiar pattern.

♀, 31-34 mm. Head whitish-brown mixed with dark brown. Palpi slightly over 1; whitish-brown irrorated with dark fuscous. Antennae grey. Thorax brown; patagia partly whitish-brown. Abdomen brown. Legs whitish-ochreous; anterior pair fuscous with whitish-ochreous basal annulations. Forewings triangular, costa gently arched, apex rounded, termen bowed, slightly oblique, crenulate; a fuscous basal patch to $\frac{1}{4}$, containing some whitish-ochreous transverse lines on costa prolonged to middle, and with an inferior tooth near extremity; remainder of disc except a costal strip, and triangular apical and tornal areas occupied by a very large whitish-ochreous blotch, suffused with brown, or dark ferruginous-brown except at edges; costal strip fuscous strigulated with whitish-ochreous; dorsal edge narrowly and interruptedly fuscous; apical and tornal triangles fuscous-brown, containing an incomplete, fine, dentate, ochreous-whitish line, sometimes forming a white spot above tornus, a white spot sometimes present on margin of central blotch above tornus; cilia fuscous partly mixed with whitish-ochreous. Hindwings with termen rounded, dentate; brownish; some whitish dots on veins; sometimes obscure pale-fuscous transverse lines; some variable white spots preceding termen; a dark-fuscous terminal line; cilia fuscous-brown. Underside whitish with many, more or less distinct, transverse lines and a broad subterminal fascia fuscous.

North Queensland: Kuranda, in November (Coll. Lyell); Evelyn Scrub, near Herberton, in October. Queensland: Brisbane, in January. Three specimens.

SCOTOCYMA EURYOCHRA, n. sp.

εὐρυωχρος, broadly pale.

♀, 34 mm. Head dark fuscous. Palpi 1; dark fuscous with a few whitish scales. Antennae fuscous. Thorax fuscous. Abdomen grey; apex fuscous. Legs fuscous; tarsi with fine ochreous-whitish annulations; posterior pair mostly ochreous-whitish. Forewings triangular, costa moderately arched, apex rounded-rectangular, termen bowed, slightly oblique, crenulate; grey-whitish with numerous, fine, indistinct, wavy, transverse lines; markings brownish-fuscous; a rather large basal patch containing some grey-whitish suffusion, limited by a slightly curved wavy line from ⅓ costa to ⅓ dorsum; median band ill-defined, mostly grey-whitish with fine lines, but with some fuscous suffusion on costa; a large apical blotch; two subterminal spots above tornus; cilia fuscous, towards centre of termen partly grey-whitish. Hindwings with termen rounded, slightly dentate; as forewings; basal patch very small; a broad terminal band, containing a subterminal series of whitish dots on veins; a dark-fuscous terminal line, interrupted by whitish dots on veins; cilia brownish-fuscous.

New South Wales: Toronto, near Newcastle, in April; one specimen. Type in Coll. Goldfinch.

Gen. CHAETOLOPHA, Warr.

Type *C. oxyntis*, Meyr. This name must be adopted for the small endemic genus, to which I formerly applied the name *Scordylia*, Gn. The areole is large and 11 widely separate. In *Eulype*, Hb., type *hastata*, Lin., which otherwise resembles it in neuration, the areole is smaller and 11 near or connate from its apex. There is, I think, no really close relationship between the two genera The species of *Chaetolopha* are narrow-winged; in the males of *oxyntis* and *leucophragma* there is a small subterminal scale-tuft on vein 2 of hindwings on underside, but this is absent in *niphosticha* and *emporias;* of the other two species I have no male to examine. The penultimate abdominal segment of the male bears a pair of lateral tufts. By boiling in potash the abdomen of the male *leucophragma* is shown to bear a pair of extrusible scent-organs on the fourth segment. In the male of *niphosticha* the termen of the hindwings is produced to form an acute central tooth.

Gen. ECCYMATOGE, Prout.

Prout, Ann. Transvaal Mus., iii., p. 207 (1913).
Type *E. melanoterma*, Prout, from South Africa.

ECCYMATOGE CALLIZONA, Low.

I am now satisfied that the type of *fulvida*, Turn., is merely an aberration of *callizona*.

ECCYMATOGE MORPHNA, n. sp.

μορφνος, dusky.

♂, 30 mm. Head fuscous; face dark fuscous with a few whitish scales. Palpi 1¼; dark fuscous with a few whitish scales. Antennae fuscous, in male thickened and minutely ciliated. Thorax and abdomen fuscous; anal valves in male large. Anterior legs dark fuscous [middle and posterior pairs broken off]. Forewings triangular, costa gently arched, apex acute, termen bowed, oblique, finely dentate; fuscous; markings dark fuscous, obscure; a small basal patch; a median fascia containing a darker discal dot beneath mid-costa, limited anteriorly by a nearly straight line from ⅓ costa to ⅓ dorsum, posteriorly by a line from ⅗ costa, strongly bent outwards in disc, with an angular prominence between veins 7 and 8, and another between 3 and 4, thence sinuate to ⅔ dorsum; an indistinct pale subterminal line; a terminal line interrupted by pale dots on veins; cilia fuscous. Hindwings with termen slightly rounded, irregularly dentate, with a stronger tooth on vein 4, as forewings, but without discal dot, and posterior edge of median fascia only slightly undulating. Underside fuscous without markings.

A true *Eccymatoge;* though vein 5 of hindwings is scarcely from below the middle of cell, the upper discocellular is bent. There appears to be no thoracic crest.

New South Wales: Mount Kosciusko (3,500 ft.), in January; one specimen.

Gen. HORISME, Hb.

Eucymatoge, Sect. I., Turn., Proc. Roy. Soc. Vict., 1903, p. 247.

Differs from *Eucymatoge* in the presence of a posterior thoracic crest.

HORISME MORTUATA, Gn.

♂, ♀, 27-30 mm. Very similar to *H. scotodes*, Turn., but slightly larger; palpi longer, 2½ to 3 as against 1½ to 2 in the latter; forewings with basal lines more evenly curved, in the latter they are more oblique; postmedian line with a doubly obtuse-toothed projection.

New South Wales: Sydney, in January and February. Victoria: Beaconsfield. Three examples.

HORISME PLAGIOGRAPHA, n. sp.

πλαγιογραφος, obliquely inscribed.

♀, 25-26 mm. Head grey. Palpi 3; grey irrorated with dark fuscous, whitish beneath towards base. Antennae grey. Thorax grey mixed with fuscous, posterior edge of crest fuscous. Abdomen grey, some fuscous scales in crests. Legs whitish, on dorsal surfaces fuscous. Forewings triangular, costa straight, slightly sinuate before apex, apex acute, termen bowed, oblique, slightly crenulate: whitish with fuscous suffusion and markings, a conspicuous dark-fuscous oblique bar from dorsum near base to middle of disc, sometimes forming a complete fascia to $\frac{1}{3}$ costa, two or three fine, incomplete, transverse lines between this and costa; a nearly straight band of three fine fuscous lines from mid-costa to dorsum at $\frac{1}{4}$; a dark-fuscous, median, subcostal, discal dot; a suffused band, towards costa resolvable into three lines, from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum, outwardly curved with slight obtuse prominences above and below middle; a streak from apex to upper prominence on postmedian line, slightly downwardly curved; between this and costa is a paler apical area; subterminal whitish, very ill-defined; a terminal line; cilia grey-whitish with a few darker points. Hindwings with termen very little rounded, dentate; whitish-grey, with fine, fuscous, transverse lines from dorsum, becoming indistinct before costa; from $\frac{1}{3}$, middle, an outwardly-curved, stronger line from $\frac{2}{3}$, a fine line following close on this, and a double subterminal line; a fuscous terminal line; cilia whitish-grey.

New South Wales: Sydney (Manly), in October; Jervis Bay, in September; two specimens. There is a third female example from the latter locality in Coll. Goldfinch, taken in November. Type in Coll. Lyell.

Gen. CIDARIA, Treit., Eur. Schmet., vi., 2, p. 140.

Mr. L. B. Prout informs me that the type is the European *C. fulvata*, Forst., and that *Hydriomena*, Hb., is a synonym of later publication. This large European genus is but poorly represented in Australia, and in New Zealand there is no endemic species, the only representative there being *subochraria*, Dbld. Six Australian species are known; of these *subochraria*, *apotoma*, *uncinata*, and *microcyma* are probably derived through the Antarctic; *scythropa* and *lasioplaca* are not nearly allied specifically to the first four, and entered Australia from the north. The groove on hindwing of male of *scythropa* I consider a character of specific value only. *Heterochasta*, Meyr., and *Polyclysta*, Gn., are derivations of this second section of the genus.

LARENTIA PETRODES, Turn.

Queensland: Warwick. Victoria: Gisborne.

LARENTIA XERODES, Meyr.

I have examined what I believe to be an example of *Xanthorhoë xerodes*, Meyr., and refer it to this genus.

LARENTIA ORIBATES, n. sp.

ὀρειβατης, a mountaineer.

♂, 28 mm. Head whitish irrorated with fuscous; face blackish. Palpi 1¼; dark fuscous. Antennae grey; pectinations in male 6, extreme apex simple. Thorax dark fuscous irrorated with whitish. Abdomen grey-whitish; paired fuscous dots on the dorsum of each segment except the first two. Legs grey-whitish; anterior and middle pairs fuscous on dorsum. Forewings triangular, costa nearly straight, slightly arched towards apex, apex pointed, termen longer than dorsum, slightly bowed, slightly oblique; whitish with numerous fine, fuscous, oblique, transverse lines; costa irrorated with fuscous; a line from ¼ costa to near base of dorsum; another parallel from ⅖ costa; a median band of three or four close lines, anterior edge from mid-costa to ¼ dorsum, nearly straight, posterior from ¾ costa to before middle of dorsum, slightly curved outwards in middle of disc; beyond and parallel is a very fine line thickened by some small dots; beyond this again three close, parallel, wavy lines; an oblique fuscous shade from apex; a narrow grey terminal fascia; an interrupted fuscous terminal line; cilia whitish with a grey median line. Hindwings with termen rounded; as forewings but all lines, except terminal line, becoming obsolete in costal area, which is whitish, and in male contains an oval patch of ochreous-grey altered scales.

Victoria: Mount St. Bernard, in February; one specimen received from Dr. W. E. Drake.

LARENTIA AGANOPIS, n. sp.

ἀγανωπις, gentle-looking.

♂, ♀, 24-32 mm. Head whitish. Palpi in male 1, in female 1¼; grey-whitish. Antennae pale grey; pectinations in male 5, extreme apex simple. Thorax ochreous-whitish. Abdomen ochreous-whitish, suffused with pale grey on dorsum. Legs fuscous; tarsi annulated with whitish; posterior pair whitish. Forewings triangular, costa gently arched, apex round-pointed, termen bowed, oblique; ochreous-whitish; markings pale grey, brownish tinged; a very small basal patch, followed by two fine parallel lines confluent on costa; median band broad from costa to middle, much narrower from middle to dorsum, darker on costa; anterior edge from ⅓ costa to ¼ dorsum, outwardly curved; posterior edge from ⅔ costa, obtusely toothed beneath costa, with a slight double-toothed median prominence, thence strongly oblique and dentate to mid-dorsum; this is followed by two fine indistinct parallel lines: an indistinct pale subterminal line preceded by a slight dark suffusion towards costa; a terminal series of triangular marks or fine, short, interneural, longitudinal streaks; cilia ochreous-whitish. Hindwings with termen rounded; ochreous-whitish, with pale, suffused, median, postmedian, and submarginal grey lines; terminal marks and cilia as forewings. Underside whitish; forewings suffused with grey as far as postmedian line; hindwings with a median transverse line.

New South Wales: Woodford, in March and April; two specimens received from Mr. Geo. Lyell. Type in Coll. Lyell.

Gen. MELITULIAS, Meyr.

I do not consider the presence of androconial scales in the male as a rule a sufficient character for generic distinction, and have therefore merged *Hypycnopa*, Low., in *Xanthorhoë*, and refrained from making a new genus for *Larentia petrodes*. But I have sacrificed strict consistency in retaining the genus *Melitulias*, Meyr., which defines a small natural group peculiar to Tasmania and South-east Australia, particularly the mountains, in which new species may be expected to occur. It is an endemic derivative of *Euphyia*. I regard *glandulata*, Gn., as the type.

MELITULIAS LEUCOGRAPHA, n. sp.

λευκογραφος, inscribed with white.

♂, ♀, 24-28 mm. Head fuscous with a few whitish scales on face. Palpi 3; fuscous; base beneath whitish, sharply defined. Antennae dark fuscous; ciliations in male imperceptible. Thorax and abdomen fuscous with a few whitish scales. Legs fuscous. Forewings triangular, costa very slightly arched, apex pointed, termen bowed, oblique, wavy; fuscous-brown; markings white partly outlined with fuscous; a fine line from $\frac{1}{5}$ costa to $\frac{1}{4}$ dorsum, curved outwards beneath costa; a broader line from $\frac{1}{3}$ costa, at first transverse, then bent inwards and joining first line above dorsum; a dark-fuscous discal dot beneath mid-costa, sometimes surrounded by a narrow whitish suffusion; sometimes a fine, sinuate, inwardly oblique line from $\frac{3}{5}$ costa not reaching middle of disc; a broader line from $\frac{5}{6}$ costa, angled inwards above and outwards at middle, then inwardly curved to dorsum before tornus; a fine interrupted subterminal line, a fine oblique streak from apex, crossing subterminal line, ending in postmedian line at its subcostal angle; a dark-fuscous terminal line; cilia fuscous barred with white. Hindwings with termen rounded; in male grey; with a large, median, oval, brownish-fuscous, androconial blotch; cilia grey; in female pale brownish-grey, a suffused, whitish, postmedian, transverse line; a whitish subterminal line; terminal line and cilia as forewings. Underside of hindwings in both sexes like upperside in female, but more distinctly marked and with a dark-fuscous antemedian discal dot.

Near *M. graphicata*, Wlk., but easily distinguished by the hindwings.

New South Wales: Mount Kosciusko (5,000 ft.), in December; three specimens. Type in Coll Goldfinch.

Gen. EUPHYIA, Hb., Verz., p. 326.

Type *E. picata*, Hb., from Europe. This genus corresponds to *Hydriomena*, Section I., of my revision. In Australia it is the dominant genus of the family, being especially well represented in South-east Australia and Tasmania; many more species will doubtless be discovered, especially in the mountains. The genus is also moderately well represented in New Zealand.

EUPHYIA SYMPHONA, Meyr.

Epirrhoë maerens, Swin. (Trans. Ent. Soc., 1902, p. 648), is a synonym (*teste* Prout, *in lit.*).

EUPHYIA TACERA, n. sp

τακερος, soft.

♂, ♀, 30-32 mm. Head brownish; face fuscous. Palpi 2; fuscous; beneath whitish-ochreous. Antennae fuscous; ciliations in male minute. Thorax and abdomen brownish-fuscous. Legs fuscous; tarsi annulated with ochreous-whitish. Forewings triangular, costa moderately arched, apex round-pointed, termen bowed, slightly oblique; whitish partly suffused with pale brownish; a small brown basal patch limited by a fine fuscous line; two ill-defined, very fine, transverse, fuscous lines follow this; median band rather narrow, brown with fine fuscous transverse lines, sometimes with a narrow central grey band; anteriorly limited by a fine, slightly outwardly-curved line from ⅓ costa to ⅓ dorsum, posteriorly by a similar line from before ⅔ costa to before ⅔ dorsum, with slight rounded prominence beneath costa, and again in middle; this is followed by a suffused whitish band containing two suffused, wavy, fuscous, transverse lines; a broad brownish terminal suffusion, containing a finely crenulate, whitish, subterminal line, preceded and followed by slight fuscous suffusion; a fuscous oblique mark beneath apex; cilia brownish-grey, apices pale grey. Hindwings with termen rounded, wavy; yellow-ochreous; three fine fuscous transverse lines from basal half of dorsum, of which only the first reaches costa; a double subterminal line from dorsum usually reaching, about middle; a narrow terminal band, sometimes obsolete towards apex; a dark-fuscous terminal line obsolete towards apex; cilia fuscous, towards apex pale yellow.

Not unlike *E. lucidulata*, Wlk., which may be at once distinguished by the indented antemedian line.

New South Wales: Barrington Top, in December; three specimens. Type in Coll. Goldfinch.

EUPHYIA PERIALLA, n. sp.

περιαλλος, excelling.

♂, ♀, 30-35 mm. Head fuscous. Palpi $2\frac{1}{4}$; fuscous, at base whitish beneath. Antennae fuscous; ciliations in male minute. Thorax fuscous. Abdomen fuscous, beneath ochreous-whitish. Legs fuscous irrorated, and tarsi annulated with whitish-ochreous. Forewings broadly triangular, costa moderately arched, apex round-pointed, termen bowed, oblique, wavy; brown with fuscous and whitish lines; a small basal patch defined by a transverse, outwardly curved line; a slightly paler fascia follows this; median band fuscous, broad on costa but narrow on dorsum, containing a paler costal area defined by a fuscous line extending nearly to middle, with a blackish discal mark near its anterior edge; fine whitish lines defining median band, anterior from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum, outwardly curved, posterior from beyond $\frac{2}{3}$ costa to before $\frac{2}{3}$ dorsum, at first transverse, then shortly incurved, and forming an obtuse double prominence in middle; two fine parallel fuscous lines follow this; a fine, interrupted, whitish, subterminal line, preceded and near apex followed by some fuscous suffusion; a dark-fuscous terminal line interrupted on veins; cilia fuscous with a whitish basal line, apices with obscure pale bars. Hindwings with termen strongly rounded, dentate; orange; towards dorsum suffused with fuscous containing many darker and paler short transverse lines; this suffusion extends on termen to middle; terminal line and cilia as forewings, but paler towards apex. Underside pale ochreous partly suffused with fuscous; both wings with discal dot, transverse lines, and terminal band fuscous, the last containing a slender, whitish, subterminal line.

New South Wales: Mount Kosciusko (4,500 ft.), in January; one male. Victoria: Mount St. Bernard, in February; two females, in Coll. Lyell. Two specimens from New South Wales (Ebor) in January and Victoria (Castlemaine, Dr. W. E. Drake) in March are probably of the same species, but the forewings are much paler except in basal patch and median band. Two since received from Mr.

G. W. Goldfinch taken on Barrington Top in December resemble the Kosciusko type.

EUPHYIA SYMMOLPA, n. sp.

συμμολπος, in harmony.

♀, 32 mm. Head fuscous; frons rounded; slightly projecting; frontal tuft whitish. Palpi 3; whitish mixed with fuscous. Antennae fuscous. Thorax and abdomen fuscous with fine whitish irroration. Legs fuscous with fine whitish irroration; posterior pair mostly whitish. Forewings triangular, costa straight except close to base and apex, apex round-pointed, termen moderately bowed, moderately oblique, slightly undulating; pale fuscous with fuscous markings; a basal patch of three or four transverse lines; a short line from dorsum to cell follows this; median band limited anteriorly by a double, nearly straight line from ⅓ costa to mid-dorsum, posteriorly by a double line from beyond ⅔ costa, at first transverse, with a strong, angular, posterior projection in middle (in one example there is a slighter angle also beneath costa), thence concave to ¾ dorsum, this line is edged posteriorly by a well-marked whitish line; a blackish discal spot in median band beneath mid-costa; a strong, crenulate, whitish, subterminal line from costa shortly before apex to tornus, edged anteriorly by a series of fuscous spots; a dark-fuscous terminal line; cilia fuscous, apical ⅔ barred with whitish. Hindwings with termen slightly rounded, slightly undulating; whitish, towards margins grey; a grey discal dot at ½; an ill-defined grey terminal band containing an undulating whitish line; terminal line and cilia as forewings.

Not unlike *C. symphona*, Meyr., but differing in the form of postmedian line, discal spot not pale centred, and other details.

New South Wales: Mount Kosciusko (6,000 to 7,000 ft.), in January; two specimens.

EUPHYIA LEPTOPHRICA, n. sp.

λεπτοφρικος, finely rippled.

♂, ♀, 34-38 mm. Head, thorax, and abdomen grey. Palpi 2½; dark grey, beneath whitish. Antennae grey; ciliations in male extremely short. Legs fuscous, irrorated, and tarsi annulated, with grey-whitish. Forewings broadly triangular, costa strongly arched, apex round-pointed, termen bowed, slightly oblique, wavy; grey, with numerous slender, finely crenulate, fuscous, transverse lines; basal patch hardly defined; median band obscurely defined, anteriorly by a slightly curved wavy line from ⅓ costa to ⅓ dorsum, posteriorly by a similar line from ¾ costa to ¾ dorsum, with a slight doubly subacute median projection; a fuscous discal dot before middle; a fine, crenulate, whitish, subterminal line; a blackish terminal line, interrupted on veins; cilia grey. Hindwings with termen rounded, wavy; pale grey with fine wavy transverse lines not reaching costa; terminal line and cilia as forewings .

Type in Coll. Goldfinch. Perhaps nearest *E. symphona*, Meyr.

New South Wales: Barrington Top, in December; two specimens.

EUPHYIA PANOCHRA, n. sp.

πανωχρος, wholly pale.

♂, ♀, 28-32 mm. Head ochreous-whitish with a very few dark-fuscous scales. Palpi 2½; ochreous-whitish with slight dark-fuscous irroration. Antennae ochreous-whitish annulated with fuscous; in male slightly thickened, ciliations ⅓. Thorax ochreous-whitish. Abdomen ochreous-whitish with a few pale-grey scales on dorsum. Legs ochreous-whitish irrorated with fuscous. Forewings broadly triangular, costa rather strongly arched, apex subrectangular, termen nearly straight, slightly oblique; ochreous-whitish, with slight pale-grey suffusion, more distinct towards termen; a very fine, often indistinct, slightly curved, slightly dentate, fuscous line from ⅓ costa to ⅓ dorsum; a second, similar, nearly straight line, finely dentate, from ⅔ costa to ⅔ dorsum; in some examples a third line or series of fine dots beyond this; cilia dark grey, apices white except on costa, beneath apex, and on tornus. Hindwings with termen rounded; ochreous-whitish, without markings; cilia grey, apices whitish. Underside of forewings suffused with grey; of hindwings with grey irroration, discal dot, postmedian, and subterminal lines.

New South Wales: Mount Kosciusko (5,000 ft.), in January. Victoria: Mount St. Bernard (5,000 ft.), in February; eight specimens. Type in Coll. Lyell.

EUPHYIA OXYODONTA, n. sp.

ὀξυοδοντος, sharply-toothed.

♀, 28 mm. Head pale grey. Palpi 2; whitish with fuscous irroration. Antennae fuscous. Thorax whitish mixed with grey. Abdomen ochreous-whitish suffused with fuscous on dorsum. Legs fuscous irrorated, and tarsi annulated, with ochreous-whitish; posterior pair mostly ochreous-whitish. Forewings triangular, costa gently arched, apex round-pointed, termen nearly straight, oblique, wavy; whitish with fuscous markings; a small basal patch with three darker lines, one of which forms its posterior edge, and is slightly rounded, slightly dentate, transverse; median band broad; its anterior edge broadly dark fuscous from ¼ costa to ¼ dorsum, strongly concave, indented above and below middle; a linear antemedian discal mark followed by two fine incomplete fuscous lines; posterior edge marked by a fine dark-fuscous line, thickened above middle, from ¾ costa, projecting slightly beneath costa, then angularly indented, with a strong median double-toothed projection, the upper tooth more prominent and acute, thence inwardly curved and dentate to ¾ dorsum, suffused fuscous spots on costa before apex, in disc beneath this, on termen beneath apex, and above tornus; an interrupted terminal line; cilia whitish with a broad fuscous median line. Hindwings with termen slightly rounded, wavy; whitish-grey; four or five faintly darker transverse lines better marked on dorsum; postmedian line with a median acute tooth; an interrupted fuscous terminal line; cilia whitish with some grey and fuscous scales.

Western Australia: Perth, in April; one specimen received from Mr. W. B. Alexander.

EUPHYIA POLIOPHASMA, n. sp.

πολιοφασμος, grey ghostly.

♂, 36-38 mm.; ♀, 32 mm. Head, thorax, and abdomen pale grey irrorated with fuscous. Palpi 2¼; fuscous, towards base ochreous-whitish. Antennae with internal surface fuscous, external whitish; in male shortly laminate, ciliations ¼. Legs pale grey irrorated with fuscous. Forewings triangular, costa gently arched, apex round-pointed, termen bowed, slightly oblique; pale grey with slight fuscous irroration; antemedian line obsolete; postmedian slender, fuscous, crenulate, slightly projecting in middle, from ⅗ costa to ⅔ dorsum, sometimes obsolete; cilia grey. Hindwings with termen rounded; whitish-grey; cilia grey, apices paler.

New South Wales: Mount Kosciusko (5,000 ft.), in December; three specimens. Type in Coll. Goldfinch.

EUPHYIA TRISSOCYMA, n. sp.

τρισσοκυμος, three times waved.

♂, 22 mm. Head grey-whitish. Palpi 2¼; fuscous, whitish beneath. Antennae grey-whitish; ciliations in male ⅕. Thorax grey-whitish; patagia with a postmedian, transverse, fuscous line. Abdomen whitish with some fuscous irroration, and paired fuscous dots on some segments. Anterior legs fuscous [middle and posterior pairs missing]. Forewings triangular, costa nearly straight, apex round-pointed, termen bowed, oblique, wavy, whitish with oblique, transverse, fuscous lines; a moderate fuscous basal patch, posterior edge from $\frac{1}{5}$ costa to near base of dorsum; two very fine incomplete lines follow this; a broad, gently outwardly curved line from mid-costa to $\frac{1}{3}$ dorsum; a dark-fuscous median discal dot; two very fine incomplete lines in median area; a broad threefold line from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum, slightly bent outwards beneath costa, and again in middle; four very fine incomplete lines follow this; a well-marked terminal line, interrupted on veins; cilia whitish, apices partly fuscous. Hindwings with termen slightly rounded, wavy; whitish; many fuscous lines from dorsum, more or less obsolete towards costa; terminal line and cilia as forewings.

New South Wales: Jervis Bay, in October; one specimen. Type in Coll. Goldfinch.

EUPHYIA APREPTA, n. sp.

ἀπρεπτος, undistinguished.

♀, 36 mm. Head and thorax fuscous. Palpi $2\frac{1}{4}$; fuscous, beneath ochreous-whitish towards base. Antennae fuscous. Abdomen fuscous with fine ochreous-whitish irroration. Legs fuscous. Forewings broadly triangular, costa moderately arched, apex rounded-rectangular, termen slightly bowed, slightly oblique, slightly crenulate; pale fuscous, basal patch and median band fuscous; basal patch small, posterior edge transverse, outwardly curved, wavy; two or three obscure lines precede median band; median band with anterior edge from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum, slightly outwardly curved, finely dentate; posterior edge from $\frac{2}{3}$ costa, at first nearly transverse, crenulate, below middle bent inwards, and again transverse to $\frac{2}{3}$ dorsum; in this band is a darker median discal dot, preceded and followed by a wavy transverse line, best marked towards costa; several faint and obscure transverse lines beyond band; a crenulate, whitish, subterminal line; a narrow fuscous terminal line; cilia pale fuscous with a darker median line. Hindwings with termen rounded, crenulate; pale grey without markings; cilia pale grey.

Victoria: Kyneton, in December; one specimen. Type in Coll. Lyell.

EUPHYIA CONIOPHYLLA, n. sp.

κονιοφυλλος, with dusty wings.

♀, 30 mm. Head reddish-brown mixed with fuscous. Palpi $3\frac{1}{2}$; fuscous, base beneath whitish. Thorax pale grey, anteriorly reddish tinged. Abdomen pale grey mixed with ochreous-whitish and fuscous, base of dorsum reddish tinged. Legs fuscous; tarsi obscurely annulated with whitish; anterior coxae reddish tinged. Forewings triangular, costa gently arched, apex acute, termen slightly bowed, oblique; whitish irrorated with fuscous-brown, which forms indistinct lines; a subbasal line from $\frac{1}{6}$ costa, at first outwardly oblique, but bent soon after origin, thence slightly curved to near base of dorsum; antemedian line very indistinct; a fuscous discal dot beneath mid-costa; postmedian very slender, from $\frac{2}{3}$ costa obliquely outwards, angled beneath costa and in middle, thence to $\frac{2}{3}$ dorsum; a fairly broad fuscous-brown terminal band, its anterior edge suffused, containing a fine, whitish, wavy, submarginal line; cilia fuscous-brown with pale basal and postmedian lines. Hindwings with termen rounded, slightly wavy; whitish irrorated with fuscous-brown, more densely towards termen; a faint whitish submarginal line; cilia grey, bases and apices paler. Underside whitish with fuscous-brown irroration and discal dots on fore- and hindwings.

New South Wales: Mount Kosciusko (5,000 ft.), in March; one specimen.

DIPLOCTENA PANTOEA, Turn.

Queensland: National Park (3,000 ft.), in February and March; seven specimens (4 males and 3 females). These are, I consider, conspecific with southern examples, though they agree ill with my description, the species being exceedingly variable. The structure of the male antennae is the same. National Park examples are distinctly green with well-defined basal patch and median band fuscous-brown, but the latter sometimes incomplete; minute white dots are sometimes present on the subterminal line, and one female has a white dorsal dot in median band. Some examples from Lorne and Ebor, though in poor condition, approach these closely, but most of the males from these localities have the forewings almost wholly fuscous-brown.

XANTHORHOE SODALIATA.

♀. *Cidaria sodaliata*, Wlk., Cat. Brit. Mus., xxv, p. 1410.

♂. *Coremia divisata*, Wlk., Cat. Brit. Mus., xxxv, p. 1682.

♀. *Xanthorhoë subidaria*, var. *urbana*, Meyr., Proc. Linn. Soc. N.S. Wales, 1890, p. 864.

This synonymy was first given by Swinhoe (Cat. Oxf. Mus., ii., p. 345), but he identified the species with Guenée's *cymaria*. I believe that Guenée's description clearly applies to one of the forms I still include under *subidaria*, Gn. Whether these are really all conspecific is open to doubt, and until the male genitalia have been examined and compared by a competent authority, this doubt is likely to continue.

Sodaliata female is very distinct by its uniform dark suffusion; the male has a uniformly dark median band on forewing, without brown or purplish tinge, while the terminal area is paler or even whitish. From eastern examples of male *subidana* I have little difficulty in distinguishing it, but some Western Australian examples (which may represent a third species) are very similar.

Northern Queensland: Atherton, Herberton, Townsville. Queensland: Eidsvold, Gayndah, Nambour, Brisbane, Stradbroke Island, Mount Tambourine, Killarney, Nanango, Stanthorpe, Roma. New South Wales: Murwillumbah, Lismore, Glen Innes, Ebor, Sydney, Moruya. Tasmania: Hobart. Also from Norfolk Island.

XANTHORHOË EPIA, n. sp.

ἤπιος, soft.

♂, ♀, 29-34 mm. Head brownish-grey, sometimes partly reddish tinged. Palpi 3; brownish-grey. Antennae grey; pectinations in male 6. Thorax and abdomen grey. Legs grey; posterior pair paler. Forewings triangular, costa nearly straight to $\frac{2}{3}$, thence arched, apex pointed, termen bowed, oblique; grey with numerous fine, oblique, fuscous, transverse lines, more or less reddish tinged; sometimes the lines and disc are wholly reddish; a small slightly darker basal patch; median band darker, moderately broad on costa and in middle, then narrowed to dorsum to half this breadth, anterior edge from $\frac{1}{3}$ costa to beyond $\frac{1}{3}$ dorsum, slightly curved, posterior edge from $\frac{2}{3}$ costa to before $\frac{2}{3}$ dorsum, very obtusely angled outwards in middle, sometimes a fuscous discal dot beneath costa before middle; cilia pale fuscous, reddish tinged, apices paler. Hindwings with termen rounded; grey; a series of alternate darker and paler transverse lines from dorsum not reaching middle; a fine, interrupted, fuscous terminal line; cilia grey.

The sexes are similar. Nearest *X. centroneura*, Meyr., which has the ground-colour much paler and contrasting with the median band, whose outer edge is more angled, and has also numerous blackish dots on veins.

New South Wales: Mount Kosciusko (5,000 ft.), in February and March; 5 male and 6 female examples.

XANTHORHOË METOPORINA, n. sp.

μετοπωρινος, autumnal.

♀, 32 mm. Head grey-whitish with dark fuscous; tuft fuscous. Palpi 2¼; fuscous; base narrowly white. Antennae grey. Thorax and abdomen grey. Legs fuscous, irrorated, and tarsi annulated with whitish. Forewings broadly triangular, costa moderately arched, apex round-pointed, termen straight, oblique, crenulate; brown-whitish; markings fuscous; a moderate basal patch, its posterior edge well defined, obliquely rounded, from $\frac{1}{6}$ costa to $\frac{1}{6}$ dorsum; a moderately broad median band, anterior edge outwardly curved, ill-defined, from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum, posterior edge from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, with a large acutely-angled median projection; several very fine, ill-defined, finely-waved lines precede and follow median band, and are traceable in the band itself; a dark-fuscous discal dot slightly before middle; a fine terminal line; cilia fuscous, bases and apices partly whitish. Hindwings with termen gently rounded, crenulate; pale grey, with indications of fine, transverse, fuscous lines towards dorsum; cilia grey, bases and apices partly whitish. Underside fuscous-grey, with dark-fuscous discal dots on fore- and hindwings.

New South Wales: Mount Kosciusko, on March 2, 1912; two specimens.

Gen. DASYSTERNICA, n. gen.

I substitute this name for *Dasysterna*, Turn., which is preoccupied.

DASYSTERNICA PERICALLES, n. sp.

περικαλλης, very beautiful.

♂, ♀, 23-27 mm. Head dark fuscous irrorated with ochreous. Palpi 3; ochreous with some dark-fuscous hairs. Antennae dark fuscous with fine whitish annulations; in male thickened and slightly laminate, ciliations $\frac{1}{4}$. Thorax dark fuscous irrorated with ochreous. Abdomen dark fuscous plentifully irrorated with ochreous; beneath ochreous. Legs pale ochreous with fuscous irroration, tarsi fuscous annulated with pale ochreous. Forewings triangular, costa slightly arched, apex round-pointed, termen bowed, oblique; fuscous with brownish and whitish irroration in parts; a basal patch limited by an outwardly curved, dark-fuscous and brownish, transverse, subbasal fascia; beyond this is a pale fascia containing some whitish irroration; median band outlined by two dark-fuscous and brown fasciae, its centre paler, with a minute, fuscous, median, discal dot sometimes indicated; anterior fascia from $\frac{1}{3}$ costa to $\frac{2}{5}$ dorsum, outwardly curved, its anterior edge twice indented and whitish; posterior fascia from $\frac{2}{3}$ costa to $\frac{4}{5}$ dorsum, its posterior edge whitish, with a small posterior tooth above middle, and a large bidentate prominence in middle; one or two fine parallel fuscous lines beyond this are sometimes traceable; sometimes an indistinct pale subterminal line; cilia fuscous, apices whitish-ochreous or barred with whitish-ochreous. Hindwings with termen rounded; orange; some fuscous irroration at base; three fine, fuscous, transverse lines, strongly angled in middle, in female obsolete; a dark-fuscous terminal band, much narrower in female; cilia as forewings. Underside ochreous; forewings with fuscous discal dot, postmedian fascia strongly dilated towards dorsum so as to join a terminal fascia, which is, however, mostly obsolete in female; hindwing with postmedian line and terminal fascia in male, in female hardly developed.

Tasmania: Cradle Mountain, in January; two specimens received from Dr. R. J. Tillyard. Type in Coll. Lyell.

DASYSTERNICA CRYPSIPHOENA, n. sp.

κρυψιφοινος, with hidden red.

♀, 26 mm. Head and palpi dark fuscous irrorated with whitish. Antennae fuscous. Thorax dark fuscous irrorated with whitish. [Abdomen broken off.] Legs dark fuscous irrorated, and tarsi annulated, with whitish [posterior pair missing]. Forewings triangular, costa slightly arched, apex round-pointed, termen bowed, slightly oblique, slightly crenulate; whitish suffused with grey and on costa with fuscous; a subbasal fuscous fascia, containing some reddish scales, not reaching dorsum; this is followed by a whitish line, and this again by a ferruginous fascia at 1/6, becoming fuscous at extremities, and containing a small patch of reddish scales beneath costa; a median band consisting of two fasciae enclosing a pale area in which is a minute, fuscous, median, discal dot; inner fascia at 1/3, outwardly curved, edged with fuscous and partly filled in with reddish-ferruginous; outer fascia from 2/3 costa at first outwardly oblique, with an obtusely-angled posterior projection beneath costa, and another, double, in middle, thence dentate to 2/3 dorsum, outlined with dark fuscous, and containing some reddish streaks on veins; a reddish-ferruginous band of suffusion separated from preceding fascia by a whitish line, and containing a wavy fuscous line; some obscure fuscous spots on termen; cilia fuscous barred with whitish. Hindwings with termen rounded; grey, with three obscure whitish lines beyond middle, parallel to termen; cilia grey, apices whitish. Underside of forewings paler than upperside, with four transverse fuscous lines, the first median, the second followed by a whitish line, the fourth by a series of whitish dots; of hindwings like that of forewings, with a discal fuscous dot at 1/3.

Type in Queensland Museum. It is possible that this may be identical with *Epirrhoë bertha*, Swin. (Trans. Ent. Soc., 1902, p. 648).

Tasmania: Mount Wellington, in January; one specimen received from Mr. G. H. Hardy.

DASYURIS MELANCHLAENA, n. sp.

μελαγχλαινος, black-cloaked.

♂, ♀, 24-28 mm. Head and thorax blackish, sometimes with a few whitish scales. Palpi 4; covered with long dense blackish hairs. Antennae blackish; ciliations in male imperceptible. Abdomen blackish; some whitish scales on apices of segments. Legs blackish. Forewings triangular, costa slightly doubly sinuate, apex round-pointed, termen bowed, oblique; dark fuscous with obscure indications of darker transverse lines, and a few scattered whitish scales; an incomplete, very slender, outwardly curved, whitish, transverse line at $\frac{1}{5}$; a better-marked whitish line from $\frac{1}{3}$ costa to $\frac{2}{5}$ dorsum, slightly curved outwards and dentate; a dark-fuscous median discal dot outlined with whitish, postmedian whitish, from $\frac{3}{4}$ costa to $\frac{4}{5}$ dorsum, sinuate, subdentate; an interrupted whitish subterminal line; cilia dark fuscous. Hindwings with termen rounded; dark fuscous; sometimes a terminal series of whitish dots on veins, cilia dark fuscous.

New South Wales: Mount Kosciusko (5,000 ft.), in December; four specimens. Type in Coll. Goldfinch.

ADDITIONAL LOCALITIES.

Sauris hirudinata, Gn.—N. Q'land: Herberton; Q'land: Nambour, Blackbutt, Mount Tambourine, National Park (2-3,000 ft.), Toowoomba; N.S. Wales: Lismore, Gosford.

S. lichenias, Meyr.—N. Q'land: Herberton; Q'land: Toowoomba.

Euchoeca rubropunctaria, Dbld.—Q'land: Coolangatta; N.S. Wales: Ebor, Nowra.

Poecilasthena thalassias, Meyr.—N. Q'land: Herberton; Q'land: Gayndah, Coolangatta, National Park (2-3,000 ft.), Toowoomba, Bunya Mountains, Stanthorpe.

P. pulchraria, Dbld.—N. Q'land: Herberton; Q'land: Stradbroke Island, Bunya Mountains (3,500 ft.), Stanthorpe; N.S. Wales: Lismore, Ebor; Vict.: Beaconsfield; Tas.: Tasman Peninsula; W. Austr.: Bridgetown, Perth.

P. balioloma, Turn.—N.S. Wales: Glen Innes; Vict.: Mount St. Bernard (5,000 ft.).

P. glaucosa, Luc.—Q'land: National Park (2-2,500 ft).

Minoa euthecta, Turn.—Q'land: Gayndah, Toowoomba, Bunya Mountains (3,500 ft.), Killarney.

Gymnoscelis delocyma, Turn.—N. Terr.: Darwin.

G. acidna, Turn.—N. Q'land: Cooktown, Cairns.

G. mesophaena, Turn.—N. Q'land: Herberton.

G. callichlora, Turn.—N. Q'land: Herberton.

G. aenictopa, Turn.—N. Q'land: Herberton.

Chloroclystis catastreptes, Meyr.—Q'land: Nambour, National Park (3,000 ft.), Toowoomba, Bunya Mountains (3,500 ft.); N.S. Wales: Katoomba, Nowra.

C. testulata, Gn.—Q'land: Toowoomba; N.S. Wales: Ebor, Mount Kosciusko; Vict.: Castlemaine.
C. insigillata, Wlk.—Q'land: Toowoomba; N.S. Wales: Ebor, Mount Kosciusko.
C. approximata, Wlk.—N. Q'land: Cairns, Herberton; Q'land: Mount Tambourine, National Park (3,000 ft.); N.S. Wales: Lismore.
C. laticostata, Wlk.—Q'land: Gayndah, Mount Tambourine, Coolangatta, National Park (3,000 ft.), Toowoomba, Killarney, Roma, Charleville; N.S. Wales: Lismore, Ebor, Nowra, Adaminaby; Vict.: Beaconsfield, Daytrap; W. Austr.: Busselton, Perth.
C. pyrrholopha, Turn.—N. Q'land: Atherton, Herberton.
C. metallospora, Turn.—Q'land: Gayndah.
C. cissocosma, Turn.—N. Q'land: Cairns, Herberton; Q'land: Nambour, National Park (3,000 ft.), Toowoomba.
C. mniochroa, Turn.—N. Q'land: Cairns, Atherton.
C. gonias, Turn.—N. Q'land: Herberton; Q'land: Stradbroke Island; N.S. Wales: Manning River.
C. alpnista, Turn.—N. Q'land: Herberton.
C. bryodes, Turn.—N. Q'land: Herberton; Q'land: Rosewood.
C. elaeopa, Turn.—N. Q'land: Herberton.
C. athaumasta, Turn.—N. Q'land: Herberton.
C. filata, Gn.—Vict.: Beaconsfield, Castlemaine; Tas.: Mount Wellington.
C. leptomita, Turn.—Q'land: Brisbane, National Park (3,000 ft.).
Tephroclystia melanolopha, Swin.—N. Q'land: Cairns, Herberton; Q'land: Nambour, Brisbane.
Mnesiloba eupitheciata, Wlk.—N. Q'land: Cairns, Herberton; Q'land: Nambour, Mount Tambourine, Southport, Toowoomba.
Microdes villosata, Gn.—N.S. Wales: Nowra, Mount Kosciusko.
M. squamulata, Gn.—N.S. Wales: Glen Innes; Vict.: Birchip; Tas.: Hobart.
Chaetolopha oxyntis, Meyr.—N. Q'land: Cairns; Q'land: Mount Tambourine, National Park (2-3,000 ft.); N.S. Wales: Lismore, Sydney.
C. leucophragma, Meyr.—Q'land: Nambour; N.S. Wales: Ebor; Vict.: Dunkeld.
C. emporias, Turn.—N. Q'land: Herberton.
C. niphosticha, Turn.—Q'land: National Park (3-4,000 ft.).
Scotocyma albinotata, Wlk.—N. Q'land: Herberton; Q'land: Nambour.
Eccymatoge callizona, Low.—N. Q'land: Herberton; Q'land: Nambour, Brisbane; N.S. Wales: Glen Innes.
Horisme peplodes, Turn.—Q'land: Caloundra, Toowoomba, Roma.
H. scotodes, Turn.—N. Q'land: Herberton; Q'land: Caloundra; N.S. Wales: Port Macquarie, Nowra.
Eucymatoge ghosha, Wlk.—N. Q'land: Herberton; Q'land: Caloundra, Stradbroke Island, National Park (3,000 ft.).
E. aorista, Turn.—N. Q'land: Innisfail, Herberton; Q'land: Blackbutt, Mount Tambourine; N.S. Wales: Lismore, Sydney.
Heterochasta conglobata, Wlk.—N. Q'land: Cairns, Herberton; Q'land: Mount Tambourine, National Park (3,000 ft.); N.S. Wales: Dorrigo, Bulli.

Polyclysta hypogrammata, Gn.—N. Q'land: Atherton, Herberton; Q'land: Stradbroke Island, National Park (3,000 ft.), Toowoomba, Bunya Mountains (3,500 ft.); N.S. Wales: Lismore.

Cidaria scythropa, Meyr.—Q'land: Nambour, Caloundra, Toowoomba, Bunya Mountains; N.S. Wales: Lismore.

C. lasioplaca, Low.—N. Q'land: Herberton; Q'land: Nambour, Toowoomba; N.S. Wales: Lismore.

C. microcyma, Meyr.—Tas.: Tasman Peninsula.

C. uncinata, Gn.—S. Austr.: Adelaide.

C. subochraria, Dbld.—Q'land: Killarney, National Park (3,000 ft.); N.S. Wales: Ebor, Mount Canoblas, Moruya, Mount Kosciusko, Adaminaby; Vict.: Moe, Dunkeld.

Larentia epicrossa, Meyr.—Tas.: Cradle Mountain.

L. dascia, Turn.—N.S. Wales: Sydney; Tas.: Tasman Peninsula.

Melitulias glandulata, Gn.—N.S. Wales: Mount Kosciusko (5,000 ft.); Tas.: Mount Wellington.

Euphyia phaedra, Meyr.—Q'land: Caloundra, Killarney; N.S. Wales: Murwillumbah.

E. interruptata, Gn.—N.S. Wales: Mount Kosciusko (3-3,500 ft.).

E. epicteta, Turn.—Tas.: Cradle Mountain.

E. rhyncota, Meyr.—Vict.: Castlemaine.

E. lucidulata, Wlk.—N.S. Wales: Ebor; Vict.: Moe; Tas.: Tasman Peninsula.

E. conifasciata, Butl.—N.S. Wales: Ebor, Mossvale, Mount Kosciusko (5,000 ft.).

E. percrassata, Wlk.—N.S. Wales: Mount Kosciusko (5,000 ft.).

E. subrectaria, Gn.—Q'land: Mount Tambourine, Rosewood, Stanthorpe; N.S. Wales: Glen Innes, Ebor; Vict.: Moe.

E. anthracinata, Gn.—Vict.: Melbourne; Tas.: Cradle Mountain, Mount Wellington.

E. strumosata, Gn.—N.S. Wales: Ebor, Sydney; Tas.: Mount Wellington.

E. vacuaria, Gn.—N.S. Wales: Mount Kosciusko (3,500-5,000 ft.); Vict.: Mount St. Bernard (5,000 ft.); Tas.: Cradle Mountain.

E. symphona, Meyr.—Vict.: Mount Erica.

E. excentrata, Gn.—Q'land: Killarney; N.S. Wales: Lismore, Armidale, Ebor.

E. aglaodes, Meyr.—Vict.: Mount St. Bernard (5,000 ft.).

E. imperviata, Wlk.—Vic.: Timberoo; S. Austr.: Adelaide; W.A.: Perth.

E. heteroleuca, Meyr.—Vict.: Mount St. Bernard.

E. languescens, Rosen.—N.S. Wales: Mount Kosciusko (5,000 ft.).

E. polycarpa, Meyr.—Tas.: Cradle Mountain.

E. chrysocyma, Meyr.—Tas.: Cradle Mountain.

E. perornata, Wlk.—Tas.: Cradle Mountain.

E. insulsata, Gn.—Vict.: Dunkeld.

E. mecynata, Gn.—Q'land: Toowoomba; N.S. Wales: Glen Innes, Ebor, Taree, Mount Kosciusko (3-3,500 ft.); Vic.: Dunkeld.

E. polyxantha, Meyr.—N.S. Wales: Ebor; Vict.: Mount Macedon.

E. trygodes, Meyr.—N.S. Wales: Ebor.

E. severata, Gn.—Q'land: Toowoomba; N.S. Wales: Nowra; W. Austr.: Perth.

E. squamulata, Warr.—Vict.: Castlemaine.

E. opipara, Turn.—N.S. Wales: Mount Kosciusko (5,000 ft.).

E. ptochopis, Turn.—N.S. Wales: Moruya.

Diploctena argocyma, Turn.—N.S. Wales: Mount Kosciusko (5,000 ft.); Vict.: Mount St. Bernard.

Xanthorhoë subidaria, Gn.—Q'land: Clermont.
X. brujata, Gn.—N. Q'land: Atherton, Herberton; Q'land: Gayndah, Stradbroke Island, Mount Tambourine, Coolangatta, National Park (3,000 ft.); N.S. Wales: Lismore, Glen Innes, Ebor; Vict.: Moe.
X. anaspila, Meyr.—Q'land: Brisbane, Toowoomba, Stanthorpe; N.S. Wales: Ebor, Mount Kosciusko (5,000 ft.).; Tas.: Mount Wellington.
X. heliacaria, Gn.—N.S. Wales: Mount Kosciusko.
X. vicissata, Gn.—Vict.: Beaconsfield, Moe, Dunkeld.
Dasyuris decisaria, Wlk.—Vict.: Castlemaine.
D. euclidiata, Gn.—N.S. Wales: Glen Innes, Ebor, Adaminaby.
D. hedylepta, Turn.—N.S. Wales: Mount Kosciusko (5-6,000 ft.).

Fam. ACIDALIADAE.

EOIS FERRILINEA, Warr.

E. cletima, Turn.

Having now a good series of this species I find that the character on which I relied for the distinction of *E. cletima*, the absence of an acute subcostal projection on postmedian line of forewing, is not trustworthy; this line varies in form.

Northern Territory: Darwin. North Queensland: Townsville. Queensland: Duaringa, Gayndah, Brisbane, Stanthorpe. New South Wales: Sydney.

EOIS COSTARIA, Wlk. *(Acidalia)*.

Acidalia albicostata, Meyr.

Queensland: Duaringa, Brisbane, Stradbroke Island, Coolangatta, Toowoomba, Stanthorpe, Chinchila, Charleville. New South Wales: Glen Innes, Sydney, Bathurst, Mount Kosciusko. Tasmania: Launceston, Deloraine.

EOIS ALBICOSTATA, Walk.

Acidalia isomorpha, Meyr.

Eois costaria, Turn.

While giving the wrong name to this species, I correctly pointed out the distinctions between it and the preceding. Not only are the posterior legs of the male quite different, but it is usually larger, more deeply pink, and the fillet is fuscous, not whitish or grey.

Northern Territory: Darwin. Northern Queensland: Herberton. Queensland: Nambour, Brisbane, Stradbroke Island, Toowoomba, Stanthorpe. New South Wales: Tabulam, Glen Innes, Sydney. Victoria: Gisborne. Tasmania: Hobart. South Australia: Mount Lofty. Western Australia: Waroona.

EOIS MILTOPHRICA, n. sp.

μιλτοφρικος, rippled with red.

♀, 18-20 mm. Head grey; face dark fuscous. Palpi scarcely 1; grey with a few dark-fuscous scales. Antennae pale grey. Thorax grey, with a minute, reddish, posterior dot. Abdomen grey with a median reddish dot on the dorsum of each segment except the first. Legs whitish; anterior pair grey. Forewings triangular, rather narrow, costa gently arched, apex round-pointed, termen bowed, oblique; grey with purple reflections; six rather broad, undulating, reddish-orange, transverse lines; first subbasal, incomplete, indicated only towards dorsum; second from ⅓ costa to ⅓ dorsum; third from mid-costa to beyond mid-dorsum; fourth from ⅔ costa to tornus; fifth from ⅚ costa to termen above tornus; sixth near termen meeting fifth; cilia grey. Hindwings with termen rounded; as forewings but with only five red lines. Underside grey with three darker postmedian lines on each wing.

Although the male is unknown, this species may be easily recognized by its red lines.

Northern Territory: Darwin, in November and December; four specimens received from Mr. F. P. Dodd.

EOIS SCAURA, n. sp.

scaurus, club-footed.

♂, ♀, 18 mm. Head pale grey; collar and face fuscous Palpi about 1; pale grey, upper-surface towards apex fuscous. Antennae grey; ciliations in male 1¼. Thorax and abdomen pale grey. Legs pale grey; posterior pair ochreous-whitish; posterior tibiae of male thickened, longer than femora, with a large expansile tuft of long hairs from base, without spurs, tarsi thickened, aborted, about ¼; of female normal but with terminal spurs only. Forewings triangular, rather narrow, costa straight to middle, thence arched, apex round-pointed, termen straight, oblique; pale grey; faintly darker, dentate, transverse lines, which are minutely dotted with dark fuscous and pale edged posteriorly, at ⅓, middle, and ⅔; a fine, wavy, pale, subterminal line; an interrupted dark-fuscous terminal line or series of dots; cilia pale grey. Hindwings with termen rounded; as forewings.

Near *E. eretmopus* but greyer, the male posterior tibiae are similar, but the tarsi much smaller and not dilated into paddle-shaped organs.

Northern Queensland: Herberton, in November and January; three specimens (1 male and 2 females) received from Mr. F. P. Dodd.

EOIS EPICYRTA, Turn.

New South Wales: Mount Kosciusko (3,500 ft.).

EOIS ELACHISTA, n. sp.

ἐλαχιστος, very small.

♂, ♀, 12-13 mm. Head ochreous-whitish; face dark fuscous. Palpi under 1; fuscous. Antennae ochreous-whitish; in male with tufts of long ciliations (3); in female slightly serrate Thorax and abdomen ochreous-whitish. Legs ochreous-whitish; posterior pair in male very short, tibiae longer than femora, slightly thickened with scales on upper-surface, without spurs, tarsi ⅓; in female with terminal spurs only. Forewings rather broadly triangular, costa straight to ⅔, thence arched, apex rounded, termen scarcely bowed, oblique; ochreous-whitish with a few dark-fuscous scales; a dark-fuscous dot on ⅓ costa; first line obsolete; a blackish discal dot beyond middle; a second dark-fuscous dot on ⅔ costa, from which proceeds a very slender, nearly obsolete, outwardly curved line, angled inwards above dorsum, ending on ¾ dorsum; some minute terminal dark fuscous dots; cilia ochreous-whitish. Hindwings with termen strongly rounded; ochreous-whitish with a few dark-fuscous scales; lines obsolete; a blackish discal spot before middle; cilia ochreous-whitish with a series of minute, subbasal, dark-fuscous dots.

Nearest *E. elaphrodes*. The antennal structure of male furnishes a good character.

Northern Territory: Darwin, in November; three specimens (1 male and 2 females) received from Mr. F. P. Dodd.

EOIS CHLORISTIS, Meyr. (*Acidalia*).

This must be an *Eois*. Meyrick states that 6 and 7 of hindwings are stalked. I have a female from Caloundra, Queensland, with terminal spurs only on posterior tibiae, to which I refer here, but unfortunately no male. The following species is closely allied.

EOIS PRIONOSTICHA, n. sp.

πριονοστιχος, with saw-like line.

♂, ♀, 19-22 mm. Head white; collar and face fuscous. Palpi under 1; fuscous or fuscous-whitish. Antennae grey; in male with tufts of moderately long cilia (1½). Thorax and abdomen white. Legs whitish; anterior pair fuscous in front; posterior pair in male short, tibiae much longer than femora (1½), smooth, dilated towards apex, without spurs, tarsi very short (⅕); in female with terminal spurs only. Forewings triangular, costa straight to near apex, apex round-pointed, termen slightly bowed, slightly oblique; white without ochreous tinge; a few scattered blackish scales and a blackish discal dot beyond middle; lines grey; first from ¼ dorsum, obsolete towards costa; second from mid-costa, irregularly dentate, curving inwards in a short incomplete circle round discal dot, ending on mid-dorsum; third from ¾ costa, finely dentate, nearly straight, to ¾ dorsum; fourth subterminal; fifth slender, submarginal; an interrupted terminal line; cilia whitish. Hindwings with termen strongly rounded; as forewings but without first line; discal dot before middle, minute or absent.

Very similar to *E. chloristis*, but Meyrick states that the posterior tarsi of male in this species are ⅓; also to *E. polygramma;* but Lower states that in this the discal dot of forewings is just anterior to median line.

Northern Territory: Darwin, in November; three specimens (1 male and 2 females) received from Mr. F. P. Dodd and Mr. G. F. Hill.

EOIS ARGOPHYLLA, n. sp.

ἀργοφυλλος white-winged.

♀, 18-20 mm. Head with fillet grey, posteriorly edged by a transverse blackish line; collar and face fuscous. Palpi 1; grey, anteriorly whitish. Antennae grey. Thorax and abdomen white. Legs whitish; anterior pair grey in front; posterior tibiae in female with terminal spurs only. Forewings triangular, costa gently arched, apex round-pointed, termen slightly bowed, oblique; shining white; without discal dot or irroration; costal edge grey; three slender, finely dentate, grey, transverse lines; first from ¼ dorsum, obsolete towards costa; second from ⅔ costa, nearly straight, to dorsum beyond middle; third nearly straight, subterminal; an interrupted grey terminal line; cilia white. Hindwings with termen rounded; as forewings.

Readily distinguished from the two preceding species by the colour of the head.

Northern Queensland: Evelyn Scrub. near Herberton, in January; two specimens received from Mr. F. P. Dodd, of which one is in Coll. Lyell.

EOIS DELOSTICTA, n. sp.

δηλοστικτος, plainly spotted.

♀, 18 mm. Head ochreous-whitish; face dark fuscous. Palpi slightly over 1; fuscous. Antennae ochreous-whitish. Thorax ochreous-whitish with a posterior dark-fuscous dot. Abdomen ochreous-whitish; first segment with two dark-fuscous dots, each remaining segment with one median dorsal dot. Legs ochreous-whitish; anterior pair fuscous in front, posterior tibiae in female with terminal spurs only. Forewings triangular, costa gently arched, apex rounded, termen bowed, oblique; ochreous-whitish with slight pale-grey suffusion and dark-fuscous dots; a median basal dot; five dots representing an antemedian line angled outwards beneath costa; a median, subcostal discal dot; a series of dots in a line from ⅗ costa to mid-dorsum; another series representing an undulating subterminal line; some grey submarginal suffusion; a terminal series of dots extending into cilia; cilia ochreous-whitish. Hindwings with termen rounded; as forewings. Underside similar.

Northern Queensland: Kuranda, in June; one specimen.

Gen. ACIDALIA, Treit.

I adopt this name for the genus to which I formerly attributed the name *Leptomeris*, Hb. The absence of long-stalking of veins 6 and 7 of the hindwings may generally be relied on as a distinguishing character from *Eois*, though short-stalking is not uncommon.

ACIDALIA DESPOLIATA, Wlk.

♂, 18 mm. Antennae moderately ciliated (1). Posterior femora of male short, tibiae elongate (2½), swollen, smooth-scaled, without spurs, tarsi very short in comparison (1/10th). No doubt the tibiae contain an internal groove and tuft of hairs which are not visible in my example. The relative sizes of femora, tibiae, and tarsi here attain their maximum disproportion. *A. optivata*, which comes next, has tibiae 2, tarsi ⅕.

I took one male at Caloundra, Queensland, in October.

Northern Queensland: Cairns; one female in Coll. Lyell. Queensland: Stradbroke Island.

ACIDALIA HYPOCHRA, Meyr.

Acidalia axiotis, Meyr.

I have received specimens from Western Australia, which differ in no way from those from Queensland.

Northern Territory: Darwin. Northern Queensland: Thursday Island, Cooktown, Cairns, Herberton, Townsville, Ravenswood. Queensland: Duaringa, Gayndah, Nambour, Brisbane, Stradbroke Island, Southport, Coolangatta, Rosewood. New South Wales: Sydney, Moruya. South Australia: Mount Lofty. Western Australia: Perth, Mundaring, York, Geraldton. Also from Norfolk Island.

ACIDALIA TENUIPES, Turn.

Northern Territory: Melville Island.

ACIDALIA SYNETHES, n. sp.

συνηθης akin.

♂, 30 mm. Head pale grey; fillet white; face blackish. Palpi about 1; grey-whitish becoming dark fuscous towards apex. Antennae grey-whitish; in male serrate, ciliations 2½. Thorax and abdomen pale grey. Legs pale grey; posterior pair in male whitish, tibiae dilated, tarsi ½. Forewings triangular, costa gently arched, apex tolerably pointed, termen slightly bowed, slightly oblique; pale grey without irroration; a dark-fuscous, subcostal, median, discal dot; lines very faintly marked; antemedian line obsolete or nearly so; a very slender, finely dentate, sinuous line from ⅔ costa to ⅗ dorsum, a similar line from ¾ costa to ⅘ dorsum, forming minute dots on veins; a very faint, whitish, dentate, subterminal line; a terminal series of fuscous interneural dots; cilia pale grey. Hindwings with termen rounded; as forewings but some grey irroration towards base, discal dot at ⅓, lines even less distinct.

Very like *A. liotis*, Meyr., from Mount Kosciusko, but greyer in colour, without any fuscous irroration, and posterior tarsi of male rather shorter relatively to tibiae. Type in Coll. Lyell.

Western Australia: Waroona, in January; one specimen received from Mr. G. F. Berthoud.

ACIDALIA PERIALURGA, n. sp.

περιαλουργος, dyed with purple all round.

♀, 29 mm. Head grey; fillet white; face dark fuscous. Palpi 1¼; whitish becoming fuscous towards apex. Antennae grey, towards base whitish. Thorax grey. Abdomen grey-whitish sparsely irrorated with fuscous. Legs grey; posterior pair and middle femora ochreous-whitish with slight fuscous irroration. Forewings triangular, costa gently arched, apex round-pointed, termen bowed, oblique; grey with a few scattered fuscous scales; some pale-purplish suffusion towards base; a minute, fuscous, median, discal dot beneath costa; a band of pale-purplish suffusion, its inner edge from ⅘ costa to ⅔ dorsum, slightly curved inwards above dorsum, outer edge formed by a fine, crenulate, fuscous line at about ⅞, thickened to form minute dots on veins; a terminal series of dark-fuscous interneural dots; cilia pale purple with a few fuscous scales, apices grey-whitish. Hindwings with termen slightly angled on vein 4, as forewings but discal spot at ⅓ and larger.

New South Wales: Port Macquarie, in March, one specimen. Type in Coll. Lyell.

STERRHA OÖPTERA, n. sp.

ὠοπτερος, oval-winged.

♀, 23 mm. Head whitish; face grey. Palpi about 1; grey. Antennae whitish-grey. Thorax and abdomen whitish-grey with slight grey irroration. Legs ochreous-whitish irrorated with grey; posterior tibiae with terminal spurs only. Forewings elongate-oval, costa gently arched, apex pointed, termen bowed, strongly oblique; whitish-grey irrorated with dark grey; a small, circular, fuscous, discal spot at ⅗; a fine, interrupted, dark-grey line from costa just before apex to ⅔ dorsum; a similar terminal line; cilia whitish with two lines of grey irroration. Hindwings suboval, narrow, termen very strongly rounded; as forewings but discal spot median, and posterior line strongly curved.

A curious-looking species, more suggestive of the genus *Pylarge* than *Sterrha*.

Queensland: Gayndah: one specimen received from Dr. Hamilton Kenny.

STERRHA EUCLASTA, n. sp.

εὐκλαστος, fragile.

♂, 24-26 mm. Head brown; fillet broadly white; face fuscous-brown. Palpi about 1, curved upwards, thickened with rough scales, terminal joint short; whitish. Antennae white; in male with fine short pectinations (½), ending in tufts of long cilia (3). Thorax and abdomen ochreous-whitish. Legs fuscous; posterior pair ochreous-whitish; posterior tibiae of male with terminal spurs only, otherwise normal. Forewings rather narrowly triangular, costa gently arched, apex pointed, termen bowed, oblique; ochreous-whitish with slight grey suffusion and a very few fuscous scales; a minute fuscous discal dot beneath mid-costa; a suffused, straight, grey line from ⅚ costa to mid-dorsum; a similar double subterminal line from apex; a third line close to terminal margin; a series of minute, interneural, fuscous, terminal dots; cilia ochreous-whitish. Hindwings with termen rounded; ochreous-whitish; a fuscous discal dot before middle; a straight grey line from apex to ¾ dorsum; a faint parallel line posterior to this; terminal dots and cilia as forewings.

New South Wales: Mount Kosciusko (3,500 to 5,000 ft.), in January; three specimens, of which one is in Coll. Goldfinch.

PROTOTYPA DRYINA, Turn.

New South Wales: Ebor Scrub (4,000 ft.).

CHRYSOCRASPEDA CRUORARIA, Warr. *(Chrysolene).*

Chrysocraspeda aurimargo, Warr.
Chrysocraspeda inundata, Warr.

I formerly regarded these as distinct. Mr. F. P. Dodd first pointed out to me that they are forms of one very variable species.

Northern Queensland: Cooktown, Cairns. Also from New Guinea.

GNAMPTOLOMA CHLOROZONARIA, Walk. *(Thalassodes).*

This name supersedes *mundissima*, Wlk.

Northern Queensland: Cairns. Queensland: Duaringa, Bundaberg, Eidsvold, Gayndah. Also from Ceylon, India, and Africa.

PERIXERA FLAVIRUBRA, Warr.

♀, 36 mm. Head brown; face whitish-ochreous with a purple transverse bar near upper edge. Palpi 3, terminal joint ½; purple, lower edge whitish-ochreous. Antennae, upper-surface fuscous, lower-surface ochreous-whitish. Thorax brown. Abdomen brown; towards apex pale grey; undersurface whitish-ochreous. Legs whitish-ochreous. Forewings triangular, costa slightly arched, apex round-pointed, termen bowed, slightly oblique, slightly dentate; yellowish-brown finely strigulated with dark brown; three fuscous dots on veins representing a subbasal line; a median discal dot, white edged with dark brown; a bisinuate line of fuscous dots from ⅝ costa to ¾ dorsum; sometimes a dark-fuscous blotch on this line above middle; a terminal series of fuscous dots; cilia brown. Hindwings with termen rounded, dentate; as forewings; discal dot at ⅓ (in one example crescentic); sometimes a dark-fuscous tornal blotch. Underside pinkish-white, with a posterior line of fuscous dots.

Northern Queensland: Cooktown, Cairns, Herberton.

PERIXERA LAPIDATA, Warr.

♂, ♀, 32-40 mm. Head whitish with a few dark-fuscous scales on vertex; upper half of face brown. Palpi in male 2¼, terminal joint ½; in female 2½, terminal joint 1; fuscous or purple-fuscous, beneath whitish. Antennae whitish; in male with slight fuscous irroration, pectinations 8, apical ⅕ simple. Thorax whitish with a few fuscous scales. Abdomen ochreous-whitish with a few fuscous or purple scales towards base of dorsum. Legs ochreous-whitish; dorsum of first two pairs and tuft on male posterior femora purple tinged. Forewings triangular, costa moderately arched, apex pointed, termen slightly bowed, oblique; whitish beset with numerous fine grey strigulae; subbasal line represented by three fuscous dots; a small, grey, pale-centred, discal spot before middle; a bisinuate, subterminal line of fuscous dots; a terminal series of blackish interneural dots; cilia whitish. Hindwings with termen gently rounded, slightly dentate; as forewings, but without subbasal dots; discal spot at $\frac{1}{3}$, larger, ochreous, outlined with fuscous. Underside whitish with fuscous discal marks and subterminal series of dots.

Northern Queensland: Cairns, Herberton. Also from New Guinea.

ANISODES PULVERULENTA, Swin.

Maculifera, Swin., and *cyclophora*, Turn., are the female of this species.

Northern Queensland: Cairns, Herberton, Townsville Also from Malay Peninsula and India.

PISORACA SIMPLEX, Warr.

The species I have described as *decretana*, Wlk., had better stand for the present under Warren's name, as it is doubtful whether it is really Walker's species.

ADDITIONAL LOCALITIES.

Mnesterodes trypheropa, Meyr.—Also from New Guinea.
Xenocentris rhopalopus, Turn.—N. Q'land: Herberton.
X. pilosata, Warr.—N. Terr.: Darwin, Melville Island; Q'land: Rosewood.
X. epipasta, Turn.—N.S. Wales: Lismore.
Eois coercita, Luc.—Q'land: Nambour.
E. liparota, Turn.—Q'land: Rosewood.
E. eretmopus, Turn.—Q'land: Gayndah, Coolangatta.
E. plumbiscriptaria, Christ.—Q'land: Eidsvold.
E. halmaea, Meyr.—N. Q'land: Claudie River; Q'land: National Park (3,000 ft.); N.S. Wales: Ebor.
E. fucosa, Warr.—N. Terr.: Darwin.
E. philocosma, Meyr. — Q'land: Gayndah, Caloundra, Mount Tambourine, Coolangatta; N.S. Wales: Glen Innes.
Acidalia lydia, Butl.—Q'land: Caloundra, Jandowae, Charleville; Vict.: Brentwood, Birchip; S. Austr.: Wynbring.
A. perlata, Wlk.—Q'land: National Park (2-3,000 ft), Killarney; N.S. Wales: Ebor, Bega, Mount Kosciusko (5,000 ft.).
A. liotis, Meyr.—Vict.: Mount St. Bernard (5,000 ft.).
A. desita, Wlk.—N. Terr.: McDonald Ranges; N. Q'land: Herberton; Q'land: Blackbutt, Rosewood.
A. rubraria, Dbld.—Q'land: Eidsvold, Gayndah, Rosewood, Coolangatta, Roma, Charleville, Cunnamulla; N.S. Wales: Bega; Vict.: Gisborne, Birchip; W. Austr.: Perth, Bridgetown.

A. sublinearia, Wlk.—N. Terr.: Darwin; Q'land: Coolangatta; N.S. Wales: Sydney.
A. prosoeca, Turn.—N. Terr.: Darwin; Q'land: Eidsvold.
A. recessata, Wlk.—N. Q'land: Herberton; Q'land: Eidsvold, Gayndah, Rosewood.
A. nictata, Gn.—N. Q'land: Cairns, Ingham.
A. oppilata, Wlk.—Q'land: Eidsvold, Gayndah, Stanthorpe, Roma, Charleville; N.S. Wales: Tabulam.
A. thysanopus, Turn.—N. Terr.: Darwin; N. Q'land: Herberton; Q'land: Killarney.
A. optivata, Wlk.—N. Q'land: Cairns, Atherton, Herberton; Q'land: Eidsvold, Gayndah, Coolangatta, Warwick, Killarney, Roma; N.S. Wales: Tabulam, Armidale, Ebor, Bega; Vict.: Birchip; W. Austr.: Harvey, Busselton, Perth.
A. caesaria, Wlk.—N. Terr.: Darwin; Q'land: Stradbroke Island.
Dasybela achroa, Low.—Vic.: Sale.
Somatina maculata, Warr.—Q'land: Eidsvold.
Problepsis clemens, Luc.—Q'land: Toowoomba.
P. sancta, Meyr.—Q'land: Blackbutt, Toowoomba.
P. cana, Hmps.—N.W. Austr.: Derby.
Ptychophyle cyphosticha, Turn.—N. Terr.: Darwin.
Gnamptoloma aventiaria, Gn.—N. Q'land: Atherton, Herberton; Q'land: Emerald, Eidsvold, Gayndah, Caloundra, Rosewood; N.S. Wales: Lismore.
Organopoda olivescens Warr.—N. Q'land: Herberton; Q'land: National Park (3,000 ft.).
Brachycola obrinaria, Gn.—N. Terr.: Darwin.
B. porphyropis, Meyr.—N. Q'land: Herberton; Q'land: Blackbutt, National Park (3,000 ft.); N.S. Wales: Lismore.
Anisodes leptopasta, Turn.—N. Q'land: Cooktown.
Pisoraca nephelospila, Meyr.—N. Q'land: Cooktown.
P. punctata, Warr.—N. Q'land: Herberton.
P. cryptorhodata, Wlk.—Q'land: Gayndah; N.S. Wales: Sydney.

Fam. GEOMETRIDAE.

Gen. IDIOCHROA, n. gen.

ἰδιοχροος, with peculiar colouring.

Frons flat. Tongue absent. Palpi minute (less than ½); porrect, shortly rough-haired. Antennae bipectinate in both sexes, extreme apex simple. Thorax and abdomen without crests; thorax not or very slightly hairy beneath. Posterior tibiae with two pairs of fully developed spurs; not dilated in male. Forewings with 7, 8, 9, 10 stalked from before angle of cell, 11 from cell, connected by a bar or anastomosing with 12. Hindwings with strong basal costal expansion, frenulum and retinaculum absent; 2 from middle of cell, 3 from well before angle widely remote from 4, 6 and 7 connate or short-stalked, 8 touching cell at a point near base, thence very gradually diverging.

Near *Cenochlora*, Warr., but has two pairs of spurs on posterior tibiae. Type *I. demissa*.

IDIOCHROA DEMISSA, n. sp.

demissus, modest.

♂, 21-22 mm. Head green; face and palpi pale fuscous. Antennae whitish; pectinations in male 10, apical ⅛ simple. Thorax green. Abdomen whitish with a broad, dull-reddish, median, dorsal streak; beneath pale fuscous. Legs whitish-ochreous; anterior pair pale fuscous. Forewings triangular, costa gently arched, apex acute, termen slightly bowed, oblique; 11 connected with 12 by a long bar; rather dark green; costal edge pale ochreous as far as middle; a fuscous dot on end of cell at about ⅗; cilia green. Hindwings with termen rounded; dull reddish; dorsum narrowly green; a darker reddish dot on end of cell; cilia whitish, slightly reddish tinged. Underside more or less suffused with dull reddish.

♀, 22 mm. Antennal pectinations 8. Face green. Hindwings pale green. Underside green. Differs from male in total absence of reddish colouring.

Queensland: Rosewood, in September; Toowoomba, in December (W. B. Barnard); six specimens.

IDIOCHROA CELIDOTA, n. sp.

κηλιδωτος, blotched.

♂, 22 mm.; ♀, 29 mm. Head white, posterior edge green; face dark reddish. Palpi very short (about ⅓); reddish. Antennae ochreous-whitish; pectinations in male 12, in female 6, extreme apex simple. Thorax green. Abdomen whitish tinged with reddish; dorsum of first two segments green; sometimes a suffused, fuscous, median, dorsal streak containing several white dots; under-surface ochreous-whitish. Legs whitish-ochreous; anterior pair reddish. Forewings triangular, costa gently arched, apex round-pointed, termen nearly straight, slightly oblique; 11 anastomosing with 12; green (inclining to bluish-green); costal edge pale ochreous; a large tornal blotch outlined with purple fuscous, whitish containing a pale-reddish streak along anterior border, and a broader pale-reddish central partition, in which are some purple-fuscous scales; cilia grey. Hindwings with termen rather irregularly rounded, tornus rather prominent; colour and cilia as forewings, but without markings. Underside whitish-green; forewings ochreous tinged with a pale-grey tornal blotch.

Queensland: Gayndah, female type received from Dr Hamilton Kenny; Rosewood, a wasted male, in April.

CYMATOPLEX HALCYONE, Meyr. *(Eucrostes).*

This name supersedes *crenulata*, Luc.

Northern Territory: Darwin. Northern Queensland: Thursday Island, Cairns, Townsville. Queensland: Caloundra, Brisbane, Stradbroke Island, Southport. Also from New Guinea.

Gen. MIXOCERA, Warr.

This name supersedes *Gynandria*, Turn. Experience has shown me that pectination of the female antennae cannot be relied on as a generic character. The genus comes near *Cymatoplex*, but 11 arises from end of cell, connate with 7, 8, 9, 10, or is short-stalked with them. In the latter genus 11 is from well before end of cell. Type *M. parvulata*, Wlk., from India. There are also five African species.

Gen. EUCROSTES, Hb.

Tongue weakly developed. Palpi slender, moderately long, porrect; terminal joint in male very short, in female longer. Femora smooth. Posterior tibiae without middle spurs. Forewings with 3 and 4 connate, 5 from above middle, 6 from upper angle, 11 from cell, anastomosing with or running into 12. Hindwings with cell short ($\frac{2}{5}$), with 3 and 4 connate, 6 and 7 connate, 12 anastomosing with cell at a point near base, thence rapidly diverging. Frenulum and retinaculum absent and hindwings with costal expansion at base in both sexes.

Near *Cymatoplex*, Turn., and *Mixocera*, Warr. Differs from the first by the shorter cell of hindwing and rather longer female palpi; from the second by the origin of 11 of forewings well before end of cell. Type *E. indigenata*, De Villers, from the Mediterranean area.

EUCROSTES IOCENTRA Meyr.

Iodis barnardae, Luc.

Mr. Prout makes *Eucrostes nanula*, Warr., a synonym; but I think Warren's type is so wasted as to be unrecognizable.

Queensland: Duaringa, Brisbane, Charleville.

Gen. IULOPS, Prout.

This genus has been made for *argocrana*, Meyr., a species which I have not seen.

EULOXIA GRATIOSATA, Gn.

I shall not follow Prout in placing this in a genus by itself under the name *Mixochroa*, Warr. The species occurs rather commonly on Mount Kosciusko at 5,000 ft., with the oblique white line on forewing feebly developed or absent.

EULOXIA ARGOCNEMIS, Meyr. *(Iodis)*.

Mr. Prout, who has doubtless examined the type, places it in this genus.

CHLOROCOMA SYMBLETA, n. sp.

συμβλητος, comparable.

♂, 36 mm. Head and face green; fillet broadly white. Palpi whitish, on upper-surface crimson. Antennae white, apical half and pectinations pale crimson; pectinations in male 5, apical $\frac{1}{6}$ simple. Thorax bluish-green. Abdomen bluish-green; tuft, sides posteriorly, and under-surface whitish. Legs pale crimson; posterior pair whitish; posterior tibiae in male dilated with internal groove and tuft. Forewings broadly triangular, costa gently arched, apex subrectangular, termen very slightly bowed, moderately oblique; 3 and 4 approximated at origin, 6 connate, 11 anastomosing with 12; bluish-green; costal edge white except near base and in apical $\frac{1}{4}$, where it is crimson; a darker green discal dot on end of cell; a very fine dentate whitish postmedian line obscurely indicated; cilia pale crimson. Hindwings with termen rounded; 3 and 4 stalked; as forewings but without costal streak and discal dot. Underside pale green.

Not unlike *C. asemanta*, Meyr., but this is a smaller species with green cilia.

New South Wales: Adaminaby (3,500 ft.), in October; one specimen.

CHLOROCOMA RHODOTHRIX, n. sp.

ῥοδοθριξ rosy-haired.

♂, 26 mm. Head and face brown; fillet broadly white. Palpi pale brown. Antennae white; pectinations fuscous [broken off except first two joints]. Thorax brown; posterior end and apices of patagia green. Abdomen green; tuft whitish; under-surface whitish-ochreous. Legs whitish; anterior and middle pairs crimson anteriorly; both spurs on middle tibiae and external spurs on posterior tibiae crimson; posterior pair in male not dilated and without internal groove and tuft. Forewings triangular, costa straight except near base and apex, apex pointed, termen very slightly bowed, oblique; 3 and 4 connate, 6 short-stalked with 7, 8, 9, 10, 11 anastomosing with 12; deep green; a broad brown costal streak from base to apex, leaving costal edge white from $\frac{1}{8}$ to $\frac{3}{4}$, and thence crimson; veins mostly faintly marked with pale crimson; termen narrowly crimson; cilia deep crimson. Hindwings with termen strongly rounded; 3 and 4 short-stalked; as forewings but without costal markings; a crimson antemedian discal dot on end of cell. Underside similar.

Tasmania: Cradle Mountain, in January (3,000-3,500 ft.); one specimen, received from Dr. R. J. Tillyard.

CHLOROCOMA MELOCROSSA, Meyr.

I now regard *C. periphracta*, Turn., as a well-marked local race of *C. melocrossa*. I have found it only on Stradbroke Island, but examples intermediate between it and the typical form occur at Coolangatta, in both instances attached to *Banksia serratifolia*.

CHLOROCOMA NEPTUNUS, Butl.

Chloëres cissina, Turn.

In describing this as a *Chloëres* I overlooked the very slender male frenulum, and minute retinaculum near to base of wing.

Queensland: Rockhampton, Gayndah, Rosewood, Toowoomba, Killarney.

CHLOROCOMA TACHYPORA, Turn.

Near the preceding but distinguishable by the white costal streak of forewings, and the face being not green but greenish-ochreous.

Queensland: Stradbroke Island, Southport.

Gen. PAMPHLEBIA, Warr.

Differs from *Chlorocoma*, Turn., in the forewings having vein 11 stalked from 10, and in the terminal joint of palpi being elongate in female. Type *P. rubrolimbraria*.

PAMPHLEBIA RUBROLIMBARIA, Gn. (*Amaurinia*).

Thalassodes diserta, Wlk.

Thalassodes simpliciaria, Wlk.

Nemoria rufotinctaria, Snel.

Chlorocoma perigrapta, Turn.

Northern Queensland: Ingham. Also from New Guinea, Borneo, Ceylon, and India. I am indebted to Mr. L. B. Prout for the identification.

Gen. GELASMA, Warr.

Prasinocyma, Warr.

Type *G. thetydaria*, Gn., from India. I am unable to separate these two genera. Those species to which *Gelasma* is restricted by Prout form a natural group, which embraces *centrophylla*, Meyr., *calaïna*, Turn., *epimitra* described below, and *orthodesma*, Low. In both *calaïna* and *orthodesma* the terminal joint of palpi in female is fully $\frac{2}{3}$, and the only structural distinction appears to be the angling of the termen of the hindwing on vein 4, which is insufficient. The genus, as I conceive it, is large but not unmanageable, comprising some 120 species.

GELASMA ISERES, n. sp.

ἰσηρης, equally fitted.

♂, 30 mm. Head and face green; fillet broadly white. Palpi short (about 1); whitish. Antennae white; pectinations in male 10, whitish-ochreous. Thorax green. Abdomen green; apex and underside whitish. Legs pale ochreous; coxae whitish. Forewings triangular, costa straight to $\frac{3}{4}$, thence gently arched, apex subrectangular, termen nearly straight, slightly oblique; green with numerous, fine, whitish, minute, transverse strigulae; a white costal streak from near base to near apex; cilia green. Hindwings with termen bowed, tornus prominent; as forewings but without costal streak. Underside whitish-green.

Very like *P. albicostata*, which differs in the longer palpi ($1\frac{1}{2}$) and whitish cilia.

Northern Territory: Darwin, one specimen received from Mr. G. F. Hill.

GELASMA LYCHNOPASTA, Turn. *(Prasinocyma).*

New South Wales: Ebor Scrub (4,000 ft.).

GELASMA EPIMITRA, n. sp.

ἐπιμιτρος, girdled.

♂, 24 mm.; ♀, 28 mm. Head bluish-green; fillet white; face green. Palpi in male $1\frac{1}{2}$, terminal joint $\frac{1}{3}$; in female $3\frac{1}{2}$, terminal joint $\frac{3}{4}$; green; under-surface white. Antennae white, towards apex ochreous tinged. Thorax bluish-green. Abdomen bluish-green; tuft and under-surface white. Legs whitish; anterior pair green on dorsum. Forewings triangular, costa moderately arched, apex round-pointed, termen bowed, oblique; 11 free; bluish-green densely irrorated, except on two transverse fasciae, with lustrous whitish scales; first fascia moderate, at $\frac{1}{3}$, indistinct towards costa; second fascia at $\frac{2}{3}$, narrow on costa, soon broadening and outwardly curved, then nearly straight and again narrower to dorsum, its anterior edge rather suffused, posterior edge sharply defined, crenulate; costal edge grey from $\frac{1}{4}$ to apex; a blackish median discal dot; a green terminal line;

cilia pale green. Hindwings with termen angled on vein 4, wavy; as forewings but without first fascia, discal dot at ⅓. Underside pale green.

Northern Queensland: Evelyn Scrub, near Herberton, in January; female type received from Mr. F. P. Dodd. New South Wales: Mount Gregson, in March; one male in Coll. Goldfinch.

GELASMA ORTHODESMA, Low.

Northern Queensland: Cairns. Also from New Guinea.

GELASMA CENTROPHYLLA, Meyr.

Northern Queensland: Herberton. Queensland: Brisbane, Stradbroke Island, Toowoomba. New South Wales: Sydney. Victoria: Melbourne, Beaconsfield, Gisborne. Tasmania: George Bay, Kelso, Georgetown.

Gen. CHRYSOCHLOROMA, Warr.

This, though nearly allied to *Gelasma*, may be separated by the strong male frenulum, and the presence of a weak frenulum in female. It contains only the one Australian species and four from New Guinea.

Gen. EUCELA, n. gen.

εὔκηλος, calm, tranquil.

Frons flat. Tongue very weakly developed. Palpi short (slightly over 1), porrect; second joint with long rough hairs beneath; terminal joint in female about ½, slender, pointed. Antennae in female simple. Thorax and abdomen without crests; thorax slighty hairy beneath. Posterior tibiae without middle spurs. Forewings with 2 from ⅔, 3 from before angle remote from 4, 5 from above middle, 6 from angle, 7, 8, 9, 10 stalked, 10 arising before 7, 11 anastomosing with 12. Hindwings with strong, basal, costal expansion, frenulum and retinaculum absent in female; cell about ½, lower discocellular oblique, costal edge of cell not much shorter than dorsal; 2 from ⅔, 3 and 4 remote at origin, 6 and 7 connate or just stalked, 8 approximated to cell near base, thence gradually diverging.

Unfortunately the male, which will probably show additional characters, is unknown, and the true position of the genus remains uncertain.

EUCELA AMALOPA, n. sp.

ἀμαλῶπος, soft-looking.

♀, 36 mm. Head and face green. Palpi and antennae whitish. Thorax green. Abdomen whitish with green dorsal and sublateral streaks. Legs whitish; coxae and anterior femora green. Forewings triangular, costa nearly straight but arched towards base and apex, apex pointed, termen nearly straight, moderately oblique; rather pale green; costal edge white; an outwardly curved white line from ⅓ costa to ⅖ dorsum; a white line, broad except towards costa, nearly straight, from ⅚ costa to mid-dorsum; cilia whitish. Hindwings with termen rounded; pale green; cilia whitish. Underside pale green with postmedian white line, preceded by a darker shade of green, on both wings.

New South Wales: Mount Kosciusko (5,000 ft.), in January; one specimen.

METALLOCHLORA NEOMELA, Meyr. *(Iodis).*

Pisina, Warr., and *albolineata*, Pagent., are synonyms.

Northern Territory: Darwin. North-western Australia: Broome. Also from New Guinea, New Britain, and Tenimber Island.

Gen. EUCYCLODES, Warr.

I am unable to agree with Mr. Prout in separating all the species except *buprestaria* to form his new genus *Anisozyga*, for *buprestaria* is closely allied to them, the slight structural differences being merely specific. Mono-specific genera should only be made for species isolated by considerable structural peculiarity; on the other hand, comparatively slight structural characters, if definite and constant, may be useful in separating two nearly related *groups* of species.

EUCYCLODES DENTATA, Warr.

I now regard this as merely a female aberration of *E. pieroides*, Wlk.

AGATHIA OCHROTYPA, n. sp.

ὠχροτυπος, pale-marked.

♀, 40-42 mm. Head and thorax bright green. Palpi 2, terminal joint ⅓; whitish, terminal joint fuscous. Antennae whitish-brown with some fuscous irroration. Abdomen bright green, beneath whitish. Legs whitish-brown; anterior pair partly suffused with fuscous. Forewings triangular, costa strongly arched, apex rectangular, termen bowed, wavy, oblique; bright green with sparse, pale-grey, transverse strigulae; markings pale grey mixed with pale ochreous-brown; costal edge pale grey with darker strigulae; an ill-defined, small, subbasal fascia; a fascia from ⅓ dorsum, not quite reaching ⅓ costa, bent outwards in middle, somewhat constricted above and below middle; a second fascia commencing in a blotch beneath $\frac{2}{3}$ costa, constricted beneath this, and again above $\frac{2}{3}$ dorsum; cilia grey. Hindwings with termen wavy, produced to an acute angle on vein 4; as forewings but with basal and antemedian fasciae; postmedian fascia expanded towards dorsum; a fuscous-brown marginal dot above terminal projection, and a larger marginal spot bisected by a whitish line beneath projection; cilia whitish, on projection fuscous, towards tornus with a fuscous basal line. Underside green-whitish with indications of postmedian fasciae.

Northern Queensland: Evelyn Scrub, near Herberton, in December and February; two specimens received from Mr. F. P. Dodd

HELICOPAGE CINEREA, Warr. (*Agathia*).

Helicopage cinerea, Prout.

♀, 40 mm. Head bright green; lower half of face and fillet grey. Palpi $2\frac{1}{2}$, terminal joint $\frac{2}{3}$; grey, basal half of under-surface whitish. Antennae grey. Thorax bright green with median and postmedian central grey spots. Abdomen pale grey with a dorsal series of large green spots; beneath whitish. Legs whitish; anterior pair fuscous anteriorly. Forewings triangular, costa moderately arched, apex acute, termen strongly bowed, oblique; bright green with broadly suffused grey markings and strigulae; costal edge pale grey with darker strigulae; a rather large basal patch containing a fuscous subcostal spot and several green spots, towards dorsum this is darker, with a very oblique inwardly directed edge; succeeding this is a narrow irregular fascia connected with a transverse median bar, which runs into postmedian fascia; a very broad fascia with darker strigulae, its edges very irregular, extending on costa from $\frac{3}{5}$ to apex, on dorsum from $\frac{3}{5}$ to tornus and adjacent part of termen, this forms an acute apical process, and contains a transverse sinuous line of fuscous dots at $\frac{2}{3}$; a grey terminal line, cilia grey. Hindwings with termen angled on vein 6, and more acutely so on vein 4; as forewings but with a small basal fascia only; postmedian fascia expanded into a large tornal blotch extending from mid-dorsum to acute angle on termen, containing a transverse series of fuscous dots and a dark wavy line from apex to tornus. Underside whitish; costa of forewings with large fuscous strigulae and a subapical blotch, from which arises a narrow transverse fascia; hindwings with a fuscous subterminal fascia thickest in middle.

Unfortunately the male is unknown. In *Helicopage* the male antennae are pectinate, and the male frenulum abnormally specialized.

Northern Queensland: Kuranda, near Cairns, in January; one specimen received from Mr. F. P. Dodd. Also from New Guinea.

Gen. CYNEOTERPNA, Prout.

Autanepsia, Turn., *praeocc.*

Type *C. wilsoni*, Feld.

Gen. HEMICHLOREÏS, Turn.

HEMICHLOREÏS THEATA, Turn.

New South Wales: Taree.

Gen. CRYPSIPHONA, Meyr.

In my revision I made *C. melanosema* the type of the genus. This was unfortunate, as Mr. Prout has pointed out, nor do I think it can be maintained. Although Mr. Meyrick did not specify the type, the name he has given to the genus (*κροψιφωνος*, with hidden colour) clearly indicates that he intended *occultaria* as the type.

CRYPSIPHONA EREMNOPIS, n. sp.

ἐρεμνωπις, dark.

♂, ♀, 32 mm. Head brown-whitish irrorated with dark fuscous. Palpi 2; fuscous, some brown-whitish scales on upper edge, base whitish beneath. Antennae fuscous; pectinations in male 5. Thorax fuscous mixed with brown-whitish. Abdomen grey. Legs, anterior pair dark fuscous [middle and posterior pairs broken off]. Forewings triangular, costa gently arched near base, thence nearly straight, apex obtusely pointed, termen bowed, oblique, crenulate; 11 anastomosing with 12 (1 male); brown-whitish suffused, and towards costa strigulated, with fuscous; markings fuscous; an indistinct, transverse, somewhat dentate line at ¼; a transverse, linear, dark-fuscous, discal mark beneath mid-costa, surrounded by some brownish suffusion; a narrow fascia, ill-defined anteriorly, posteriorly sharply defined by whitish, at first bent outwards and very sharply dentate, abruptly bent inwards below middle, and ending as a fine line to ¾ dorsum; an indistinct, whitish, dentate, subterminal line, anteriorly edged by sharp fuscous teeth; some brownish suffusion between this and termen; a dark-fuscous terminal line; cilia fuscous, narrowly barred with white between veins. Hindwings with termen rounded, crenulate; rather dark grey; an obscure, darker, dentate, postmedian line; a dark-fuscous terminal line; cilia as forewings. Underside whitish suffused with fuscous, with obscure dark postmedian line on both wings.

In the absence of the hindlegs I cannot be sure that this is a *Crypsiphona*, but the total absence of abdominal crests makes it probable.

Western Australia: Cunderdin, in October, one male received from Mr. R. Illidge; Mount Barker, one female (L. J. Newman).

Gen. PINGASA, Moore.

Differs from *Terpna* in having crests of scales on upper-surface of hindwings. The distinction seems natural and tenable. So far I agree with Prout, but cannot follow him in separating from it a new genus *Hypodoxa;* the former with cell of hindwings short, scale-tuft at its end; the latter with cell normal, scale-tuft before its end. I have carefully noted (without actual measurement) the comparative length of the cell of the hindwing in seven Australian species. The dorsal edge of the cell is longer than the costal, and I have made my comparisons from the length of the costal edge. In *chlora* it is about 2/5; in *cinerea* between 2/5 and 1/2, in *emiliaria*, *muscosaria*, *myriosticta*, and *erebata* about 1/2; in *deteriorata* about 3/5. These differences and slight variations in the position of the scale-tufts appear to me to be of specific value only.

Type *P. ruginaria*, Gn., from India and Africa

PINGASA MUSCOSARIA, Gn.

This species varies much according to locality. It would be easy to distinguish local races or subspecies, probably a longer series will show these to be connected by intermediate forms.

PINGASA ACUTANGULA, Warr.

♀, 42-46 mm. Head brownish, on sides whitish. Palpi rather long, ascending; terminal joint as long as second joint, porrect, whitish. Antennae fuscous, towards base fuscous-whitish. Thorax whitish with a central brownish suffusion. Abdomen whitish suffused with fuscous and brownish; a double median reddish-brown line, enclosing crests, which are brownish, underside whitish. Legs, anterior pair fuscous, coxae whitish [middle and posterior pairs broken off]. Forewings triangular, costa gently arched, apex round-pointed, termen bowed, crenulate; whitish with fine pale-brown or grey irroration; lines fine, blackish, becoming reddish on dentations; first from 1/4 costa, acutely angled inwards beneath costa, then prolonged outwards nearly to middle of disc, where it forms a narrow quadrangular process, in which is included a brownish linear discal mark, returning it forms an acute angle on disc beneath subcostal angle, beneath this a double prominence on vein 1 and ends on dorsum, near base; second line from ⅔ costa towards termen, acutely dentate six times, then bent inwards to dorsum near middle, with a seventh dentation above dorsum; terminal area darkly suffused with brown and fuscous beyond second line, and a short reddish line connecting sixth dentation with tornus; an obscure whitish dentate subterminal line; a suffused paler spot on termen below middle; a dark terminal line; cilia whitish obscurely barred with brownish. Hindwings similar but without first line, discal mark small or absent. Underside white; both wings with a blackish terminal band, and white apical and median terminal spots; forewings with linear discal mark.

Easily recognized by the peculiarly angulated first line of forewings.

Northern Queensland: Coen River (W. D. Dodd), one specimen in South Australian Museum; Kuranda (from F. P. Dodd in Coll. Lyell). Also from New Guinea.

PINGASA ATRISCRIPTA, Warr.

Hypochroma munita, Luc.

I do not know this species and have merely transcribed Prout's identification.

Northern Queensland: Cairns. Also from New Guinea.

Gen. AEOLOCHROMA, Prout.

Type *A. turneri*, Luc.

Mr. Prout refers here all the remaining Australian species of the group except *paroptila* (doubtfully) and *percomptaria*. These two he retains in *Terpna*, which he distinguishes by the frons being strongly protuberant But in *percomptaria* this is not the case, and being therefore doubtful of the validity of his distinction, I propose to retain all these species in *Terpna* except the type, defining the genus *Aeolochroma* by the simple male antennae. It differs from *Actenochroma*, Warr., in having strong abdominal crests.

Gen. TERPNA, H.-Sch.

T. saturataria, Wlk., cannot be included in the Australian list at present. It may occur in Queensland, but Swinhoe's reference to Western Australia is almost certainly erroneous.

TERPNA UNITARIA, Wlk *(Tephrosia)*.

Hypochroma acanthina, Meyr.

I do not know this species.

TERPNA HYPOCHROMARIA, Gn.

The male of this species has a small notch preceded by a small tuft of hairs on the dorsum of the antenna near its base. No doubt this is a scent-producing organ.

Northern Queensland: Cape York. Queensland: Brisbane, Toowoomba New South Wales.

Gen. STERICTOPSIS, Warr.

Mr. Prout, who has examined the type of *paratorna*, Meyr., states (Gen. Ins. Hemith., p. 24) that it does not belong to this genus, for 10 is stalked with 7, 8, 9. It has scarcely any dorsal crests and the male antennal pectinations are short. *Argyraspis*, Low., is from the same locality probably, and therefore may be identical with it. The two Gisborne examples, which I examined, agreed structurally with *inconsequens*, Warr., which is from Duaringa, but I will not be sure that they are the same species. I accept, of course, Mr. Prout's observations, but am unable for want of material to clear up the confusion, which at present undoubtedly exists.

ADDITIONAL LOCALITIES.

Comostola laesaria, Wlk.—Q'land: Gayndah, Caloundra, Stradbroke Island, Mount Tambourine, Coolangatta, Rosewood, Toowoomba; N.S. Wales: Lismore.
Pyrrhorhachis pyrrhogona, Wlk.—Q'land: Gayndah, Rosewood.
Chloëres citrolimbaria, Gn.—Q'land: Blackbutt, National Park (2-3,000 ft.); N.S. Wales: Lismore, Port Hacking.
Mixocera latilineata, Wlk.—Q'land: Gayndah, Caloundra, Toowoomba; N.S. Wales: Lismore, Tabulam.
Euloxia meandraria, Gn.—N.S. Wales: Ebor, Mount Kosciusko (3,500-5,000 ft.).
E. fugitivaria, Gn.—N.S. Wales: Glen Innes, Mount Kosciusko (5,000 ft.).
E. pyropa, Meyr.—W. Austr.: Harvey.
Chlorocoma cadmaria, Gn.—Q'land: Coolangatta; N.S. Wales: Glen Innes.
C. dichloraria, Gn.—Q'land: Brisbane, Blackbutt.
C. assimilis, Luc.—W. Austr.: Donnybrook.
C. externa, Wlk.—Q'land: Toowoomba.
C. monocyma, Meyr.—S. Austr.: Port Augusta.
C. melocrossa, Meyr.—Q'land: Stradbroke Island. Coolangatta; Tas.: Hobart, Tasman Peninsula.
Comibaena mariae, Luc.—Q'land: Gayndah, Rosewood, Toowoomba.
Thalassodes veraria, Gn.—N. Terr.: Darwin; N.S. Wales: Lismore.
Gelasma rhodocosma, Meyr.—N. Terr.: Darwin; N. Q'land: Cairns; Q'land: Gayndah.
G. ocyptera, Meyr.—Q'land: Clermont, Gayndah, Toowoomba, Charleville.
G. albicosta, Wlk.—N. Terr.: Melville Island; N. Q'land: Cairns.

G. iosticta, Meyr.—N. Q'land: Herberton; Q'land: Stradbroke Island; N.S. Wales: Lismore.
G. calaina, Turn.—Q'land: Montville (1,500 ft.) near Nambour, National Park (3,000 ft.), Toowoomba.
G. centrophylla, Meyr.—N.S. Wales: Port Macquarie.
G. floresaria, Wlk.—N. Q'land: Herberton.
Hemithea insularia, Gn.—N. Terr.: Darwin.
Metallochlora decorata, Warr.—N. Q'land: Herberton.
M. venusta, Warr.—N. Q'land: Atherton.
Urolitha bipunctifera, Wlk.—Q'land: Gayndah, Toowoomba; N.S. Wales: Lismore. Also from Lord Howe Island.
Uliocnemis partita, Wlk.—N. Q'land: Claudie River.
Eucyclodes pieroides, Wlk.—N. Terr.: Darwin; N. Q'land, Cooktown, Cairns; Q'land: Gayndah, Coolangatta; N.S. Wales: Lismore.
E. fascinans, Luc.—N.S. Wales: Lismore.
E. insperata, Wlk.—Q'land: Toowoomba; N.S. Wales: Lismore.
E. metaspila, Wlk.—Q'land: Nambour, Mount Tambourine.
E. buprestaria, Gn.—Q'land: Coolangatta; Tas.: Cygnet.
Chlorodes boisduvalaria, Le G.—N.S. Wales: Ebor; Tas.: Hobart.
Agathia laetata, Fab.—Q'land: Nambour, Rosewood; N.S. Wales: Lismore.
Crypsiphona occultaria, Don.—N. Terr.: Darwin; Q'land: Toowoomba, Charleville; N.S. Wales: Lismore; Vict.: Birchip; Tas.: Tasman Peninsula, Cygnet.
Pingasa muscosaria, Gn.—Q'land: Nambour, Toowoomba; N.S. Wales: Lismore, Ebor, Albyn River.
P. emiliaria, Gn.—N.S. Wales: Lismore.
P. myriosticta, Turn.—N.S. Wales: Lismore.
P. erebata, Wlk.—N. Terr.: Darwin; Q'land: Yeppoon, Caloundra.
P. chlora, Cram.—Q'land: Coolangatta.
P. cinerea, Warr.—Q'land: Nambour, Caloundra, Toowoomba.
Terpna metarhodata, Wlk.—Q'land: Gayndah.
T. hypochromaria, Gn.—Q'land: Gayndah, Nanango, Toowoomba; N.S. Wales: Lismore.
T. quadrilinea, Luc.—Q'land: Gayndah: N.S. Wales: Lismore, Port Macquarie.
T. percomptaria, Gn.—Q'land: Toowoomba.
Rhuma subaurata, Wlk.—N.S. Wales: Taree.
Heliomystis electrica, Meyr.—N.S. Wales: Mount Kosciusko (5,000 ft.).

Fam. BOARMIADAE.

CLEORA LACTEATA, Warr. *(Chogada)*.

This name must be adopted for the species, which, following Meyrick, I have described under the name of *illustraria*, Wlk. I have since examined the type of *illustraria* and find that is referable to the species for which I have adopted the name *acaciaria*, Bdv.

Also from New Guinea and New Britain.

BOARMIA ZASCIA, Meyr.

Specimens from Armidale and Stanthorpe are much paler than those from Victoria, the general coloration being greyish, and the vertex of head is grey, but the face is always blackish.

Queensland: Stanthorpe, in October. New South Wales. Armidale. Victoria: Melbourne, Beaconsfield.

BOARMIA PANCONITA, Turn.

Nearly allied to *B. zascia*. It is darker than the northern examples of this species, from which it may be always distinguished by the lower part of the face being white, and by the crescentic discal mark on the hindwing. [The female example with wholly blackish face, which I formerly referred to this species, is an example of *zascia*.] The Gayndah examples apparently represent a distinct local race.

Queensland: Gayndah, Stanthorpe, in October

BOARMIA DESTINATARIA, Gn.

Also allied to the two preceding species, and like them variable, but readily distinguished by the paler suffused coloration more or less tinged with ochreous, and the absence of any black on the face.

Queensland: Stanthorpe, in October. New South Wales: Ebor, Sydney, Katoomba. Tasmania.

BOARMIA PISSINOPA, n. sp.

πισσινωπος, black as pitch.

♂, 42 mm. Head, palpi, antennae, and thorax blackish. Antennal pectinations in male 10, apical $\frac{1}{6}$ simple. Abdomen on dorsum fuscous becoming blackish towards base; lower-surface, sides, and tuft grey-whitish. Legs fuscous; posterior pair grey. Forewings triangular, costa nearly straight, apex round-pointed, termen bowed, oblique, slightly crenulate, blackish; markings intensely black; a fine transverse line from $\frac{1}{3}$ costa, bent strongly inwards beneath costa, and again bent to $\frac{1}{6}$ dorsum; a thicker oblique shade from mid-costa to dorsum before middle; a transverse, median, subcostal discal mark; a slightly dentate line from $\frac{3}{4}$ costa, strongly bent inwards to mid-dorsum; a faint, incomplete, dentate subterminal line; a fine terminal line; cilia dark fuscous. Hindwings with termen gently rounded, obtusely dentate; as forewings but without first line, other lines transverse, gently rounded.

In colour this species resembles *Melanodes anthracitaria*, Gn., and both are adapted for concealment on tree-trunks blackened by fire.

Western Australia: Perth, in October; one specimen.

BOARMIA MACULATA, Luc.

Queensland: National Park (3,000 ft.), in March; a series taken at light. These agree with two examples from

Kuranda which I have identified at *maculata*, Luc., in structure of male antennae, neuration (10 and 11 stalked, free; 6 males and 4 females), and markings, but they are larger (52-58 mm.) and much greener in coloration.

ABRAXAS SPOROCROSSA, n. sp.

σποροκροσσος, with spotted border.

♂, ♀, 46-50 mm. Head yellow with three fuscous dots on crown and sometimes another on face. Palpi fuscous, towards base yellowish. Antennae fuscous; ciliations in male $\frac{1}{2}$. Thorax fuscous; middle of patagia and two posterior dots yellow. Abdomen fuscous on dorsum; bases of segments broadly yellow, each yellow bar containing a pair of lateral spots; ventral surface yellow with paired fuscous spots. Legs fuscous-grey; coxae and posterior femora partly yellowish. Forewings triangular, costa strongly arched, apex rounded, termen bowed, oblique; blackish; a yellow dot beneath costa near base, followed by a median whitish dot, which is sometimes connected with a subcostal dot at $\frac{1}{6}$, these are more or less yellow tinged; a quadrangular white spot beneath $\frac{1}{3}$ costa; a triangular blotch on mid-dorsum, its apex acute and reaching nearly to middle of disc; a white blotch beneath $\frac{2}{3}$ costa, irregular in outline, reaching below middle of disc, convex posteriorly, concave and more or less wavy anteriorly, followed by a minute subcostal dot; a white dot before tornus, sometimes prolonged into disc; a subterminal series of six or seven small quadrangular white spots, the two central reduced to dots; cilia blackish. Hindwings with termen gently rounded; white; a triangular basal blackish blotch to $\frac{1}{4}$; a blackish terminal band containing a series of quadrangular white dots; cilia blackish. Underside similar.

Northern Queensland: Claudie River, in December; two specimens taken by Mr. J. A. Kershaw. Type in National Museum, Melbourne.

Gen. XYLODRYAS, n. gen.

ξυλοδρυας, a woodnymph.

Frons flat. Tongue well developed. Palpi moderate, porrect; basal and second joints shortly rough-scaled; terminal joint short. Antennae in male simple, minutely ciliated. Thorax with a small posterior crest; slightly hairy beneath. Abdomen not crested. Femora smooth. Posterior tibiae in male not dilated. Forewings broadly triangular, costa strongly arched towards base, termen excavated between veins 4 and 6; in male without fovea; 2 from $\frac{2}{3}$, 7, 8, 9, 10 stalked, 10 connected with 8, 9 beyond 7, 11 connected with

12. Hindwings obtusely angled on veins 4 and 7; 2 from $\frac{2}{3}$, 3 and 4 widely separate, 6 and 7 separate, 8 closely approximated to cell to beyond middle.

Type *X. leptoxantha*, which I formerly included, while pointing out the differences, with *Coelocrossa*, Turn. On reconsideration it appears to me generically distinct, and perhaps not closely allied. Apart from minor differences the structure of vein 8 of hindwings affords an important distinction. I suspect some affinity with *Lyelliana*, Turn., and *Lophosema*, Turn.

I think this is probably, with a few other *Geometridae*, part of the aboriginal fauna of the Eastern Islands before they became part of the Australian continent.

XYLODRYAS LEPTOXANTHA, Turn.

I took one male on the wing by lantern light in the National Park, Queensland (2,500-3,000 ft), in December.

The species is not confined to the mountains, for I have received from Mr. G. N. Newman a very similar specimen taken at Rous, near Lismore, New South Wales. A second example taken in the National Park in March is a very distinct aberration, purplish-grey, with faint lines, little irroration, but a small whitish spot near base of forewing, and others near termen of both wings.

BURSADA FLAVANNULATA, Warr.

♂, ♀, 24-30 mm. Head and thorax blackish; face and palpi ochreous-whitish or grey-whitish. Antennae blackish; pectinations in male 12, in female 4. Abdomen blackish; a transverse subbasal yellow or orange line on dorsum. Legs fuscous. Forewings triangular, rather narrow, costa gently arched, apex rounded, termen bowed, oblique; blackish; an oblique oval yellow or orange blotch extending from beneath $\frac{2}{3}$ costa to above termen beyond tornus; cilia blackish. Hindwings with termen rounded; yellow or orange; a blackish terminal band, sharply defined, broad at apex and tornus, narrower on mid-termen, ending rectangularly above tornus, but giving off a subdorsal streak towards base, cilia blackish. Underside similar.

Northern Queensland: Claudie River, in March; two specimens taken by Mr. J. A. Kershaw. Also from New Guinea.

Gen. CLEPSIPHRON, n. gen.

κλεψιφρων, deceiving.

Frons flat. Tongue present. Palpi short, porrect, projecting only slightly beyond frons; second joint shortly rough-scaled; terminal joint very short, depressed. Antennae in male simple, minutely ciliated. Thorax and abdomen without crests; thorax smooth beneath. Femora smooth; all tibial spurs present; inner twice as long as outer. Forewings with base of costa rounded; in male without fovea; 2, 3, 4 equidistant, 5 from middle of cell, 6 from upper angle, 7, 8, 9, 10, 11 stalked from considerably before angle, 11 only short-stalked, connected first with 12 and then with stalk of 7, 8, 9, 10. Hindwings broad; cell about $\frac{2}{5}$; 5 absent, 6 and 7 separate, the latter arising from shortly before angle, 8 connected with cell near base, thence diverging.

A peculiar genus, but probably related to *Peridelias*, Turn., *Aplochlora*, Warr., and *Parametrodes*, Warr.

CLEPSIPHRON CALYCOPIS, n. sp.

καλυκωπις, roseate.

♂, 20 mm. Head ochreous-grey; face with some reddish scales; posterior margin of eyes reddish. Palpi ochreous-whitish; second joint barred with reddish in middle and at apex. Antennae whitish-grey. Thorax purplish-grey. Abdomen reddish-grey; tuft ochreous-whitish. Legs ochreous-whitish; anterior femora and tibiae reddish tinged; anterior tarsi fuscous tinged. Forewings broadly triangular, costa strongly rounded at base, thence slightly arched, apex rectangular, costa not oblique, slightly sinuate; purple-fuscous; base of costa purple; an ill-defined darker basal patch; an outwardly curved fuscous line from $\frac{1}{3}$ costa to dorsum before middle, indistinct towards costa, towards dorsum well defined and mixed with orange; a line from $\frac{2}{3}$ costa, at first outwardly curved, but bent inwards and then angled outwards above dorsum, ending on dorsum before tornus, orange becoming fuscous towards costa; termen with a narrow, irregularly-indented, yellow margin; cilia pale yellow. Hindwings with termen wavy and slightly angled on vein 4; purple-fuscous, the greater part of disc suffused with reddish and orange with small purple-fuscous strigulae; terminal margin and cilia as forewings. Underside grey with traces of whitish postmedian line, and with whitish terminal margin.

Northern Queensland: Evelyn Scrub, near Herberton, in January; one specimen received from Mr. F. P. Dodd. Type in Coll. Lyell.

Gen. PICROPHYLLA, n. gen.

πικροφυλλος, with pointed wings.

Frons with an anterior tuft of scales. Tongue well developed. Palpi rather short, porrect; second joint rough-haired; terminal joint short. Antennae of male simple, ciliations minute. Thorax and abdomen without crests, thorax slightly hairy beneath. Femora smooth; posterior femora of male dilated with internal groove and tuft. Forewings in male without fovea; 10 and 11 long-stalked, 10 anastomosing with 8, 9 beyond 7. Hindwings with apex produced to a sharp point on vein 7; 3 and 4 approximated at origin; 6 and 7 separate, 7 arising before angle of cell, 8 closely approximated to cell for nearly its whole length.

Probably allied to *Tessarotis*, Warr., which approaches it closely in wing shape, but has 10 and 11 arising separately.

PICROPHYLLA HYLEORA, n. sp.

ὑληωρος, of the woods.

♂, ♀, 40 mm. Head fuscous-brown. Palpi 1¼; fuscous-brown. Antennae ochreous-whitish, dorsum except towards apex suffused with fuscous-brown. Thorax brown-whitish; a postmedian pair of fuscous dots. Abdomen brown-whitish; paired fuscous dots on dorsum of second and third segments. Legs whitish-ochreous speckled with dark fuscous. Forewings triangular, costa slightly arched, apex acute, produced, termen sinuate beneath apex, angled on vein 4, thence slightly concave to tornus; brown-whitish with sparsely scattered, dark-fuscous, transverse strigulae, more numerous on costa, towards base, and towards termen; a suffused fuscous line from ⅓ costa with two posterior teeth, beneath costa and in middle, obsolete towards dorsum; a fine, straight, fuscous-brown line from costa before apex to ⅔ dorsum, succeeded by a parallel row of fuscous dots; a dark-fuscous discal dot beneath ⅔ costa; cilia fuscous, on costa and from beneath apex to angle brown-whitish. Hindwings produced to a sharp point on vein 7, termen beneath this sinuate, thence nearly straight; as forewings with fewer strigulae; without first line; second line median; a subterminal series of fuscous dots; cilia brown-whitish. Underside similar.

Queensland: Eumundi, near Nambour, in January; National Park (3,000 ft.), in March; two specimens

CASBIA RHODOPTILA, Turn.

In addition to the type I have now a female (26 mm.) from Northern Territory, Darwin (G. F. Hill) without spots on forewing; and a male (30 mm.) from Queensland, Stradbroke Island, in August, with discal dot, but without posterior spot. The reddish head and tegulae form a good distinguishing mark of this species. In all my three examples vein 11 of forewing anastomoses with 12.

IDIODES ARGILLINA, n. sp.

ἀργίλλινος, clay-coloured.

♂, 44 mm. Head and thorax brown. Palpi about 1; brown. Antennae dark grey. Abdomen grey; dorsum brown towards base. Legs grey; anterior pair fuscous. Forewings broadly triangular, costa gently arched, apex obtusely pointed, termen slightly bowed, slightly oblique; brown with numerous fine transverse fuscous strigulae, these are most numerous on costa, present also towards margins, and across main veins; a large suffused fuscous blotch, its margins composed of coalesced strigulae, extends on costa from middle to apex, narrowing dorsally it terminates abruptly on vein 2; an indistinct, very narrow, interrupted, pale, oblique line from apex, traversing the dark blotch towards ¾ dorsum; cilia brown. Hindwings with termen slightly rounded; colour and strigulae as forewings, but without blotch; a suffused darker-brown line from mid-dorsum towards ⅓ costa; in this a small fuscous discal spot; cilia brown. Underside similar.

Nearest *I. fictilis*, Turn.

Queensland: National Park (3,000-3,500 ft.), in January; one specimen.

Gen XENOMUSA, Meyr.

Frons smooth, not projecting. Tongue well developed. Palpi short (1 or less), hairy beneath. Antennae in male simple or bipectinate. Thorax not crested; beneath hairy. Abdomen without crests. Femora smooth-scaled. Posterior tibiae with all spurs present; in male not dilated. Forewings with apex uncinate and slightly produced; cell over ½, discocellulars nearly straight, or inwardly curved, 2 from ¾, 3 and 4 separate, 5 from or from above middle, rather weakly developed, 6 separate or short-stalked, 10 from cell or short-stalked with 7, 8, 9, 10 and 11 free. Hindwings with 2 from ⅔ or ¾, 3 and 4 separate, 5 obsolete or weakly developed, 6 and 7 separate, 12 closely approximated to cell as far as middle.

Meyrick placed this among the *Oenochromidae*. In *X. metallica*, vein 5 of hindwings is obsolete, being concealed in a fold of the wing membrane; in *X. rubra* it is present, but weak. I think the two must be regarded as congeneric in spite of this and the difference in antennal structure. *X. monoda*, the type species, I have seen, but have no specimens for examination. The genus should be placed, I think, in Boarmiadae, of which it is a primitive form. In *X. rubra* a forked median vein is plainly visible in the cell.

XENOMUSA METALLICA, Luc.

♂, 34 mm.; ♀, 40-45 mm. Head brownish or grey; two whitish spots or a white line on lower edge of face. Palpi in male ½, in female ⅔; whitish or whitish-ochreous, apex blackish. Antennae grey; in male simple, minutely ciliated. Thorax brownish or grey. Abdomen brownish or grey with sparsely scattered blackish scales. Legs ochreous-whitish; tibiae and tarsi annulated with dark fuscous. Forewings elongate-triangular, narrower in male, costa bisinuate, more strongly so in male, apex uncinate, produced, termen bowed, oblique; 10 short-stalked (1 male and 7 females); brownish or grey usually with sparsely scattered blackish scales; usually a whitish-ochreous spot on base of costa; a fuscous or brownish line from ⅓ costa very obliquely outwards, sharply angled beneath costa, thence very obliquely inwards to dorsum near base; a similar line, posteriorly edged with whitish, from beneath costa before apex, nearly straight, to dorsum before middle; usually a minute, blackish, median, discal dot beneath costa; apex fuscous preceded by whitish; a short oblique line or fuscous shade from apex to beneath second line; cilia fuscous. Hindwings with termen very slightly rounded, tornus prominent; colour and cilia as forewings; a straight transverse brownish or fuscous line at ⅓; a white, median, discal dot.

Northern Queensland: Kuranda, in April; one male. Queensland: Montville, near Nambour, in March; Brisbane, in January and March; seven females.

XENOMUSA RUBRA, Luc.

♀, 50 mm. Head pale reddish; face reddish-orange. Palpi 1; reddish-orange. Antennae reddish-orange; in female shortly bipectinate (1½), apical ⅙ simple. Thorax pale reddish. Abdomen ochreous. Legs pale ochreous. Forewings triangular, costa gently bisinuate, apex produced, slightly uncinate, termen sinuate, oblique; 10 from cell; reddish-orange without markings; cilia reddish-orange. Hindwings with termen slightly rounded, tornus rather prominent; as forewings.

My description is taken from Dr. Lucas' type, which is in my possession, and still, I believe, remains unique.

Queensland: Brisbane.

Gen. DIRCE, Prout.

Oenone, Meyr., *praeocc.*

This genus must be transferred to the Boarmiadae, for descaling shows that vein 5 of the hindwings is absent. Previous authors have been deceived by the presence of a persistent fold of the wing-membrane in the normal position of this vein. On the other hand, *Diceratucha*, Swin., has vein 5 of hindwings sufficiently well developed, and must be retained in the Oenochromidae. The two genera agree in the neuration of the forewing, in which the areole is of a primitive form, and no doubt there is real relationship between them. In fact, the latter genus is probably very near the point, where the primitive stem of the Boarmiadae diverged from the Oenochromidae.

I can see no valid grounds for the conjectures of Meyrick and Prout for any near relationship to *Brephos*, which has completely lost the areole. Its points of resemblance to *Dirçe* are merely superficial (general hairiness and colour scheme) and adaptational. Hairiness is a common character in genera of mountain localities, and is probably a protection against the dampness of mountain mists.

DIRCE AESIODORA, n. sp.

ἀισιοδωρος, a fortunate gift.

♂, ♀, 26-30 mm. Head blackish with a white central spot on crown; face white, hairs on margins blackish. Palpi projecting somewhat beyond frons; white; some hairs, apex of second joint, and whole of terminal joint blackish. Antennae blackish; in male thickened, serrate, and minutely ciliated. Thorax blackish irrorated with whitish. Abdomen dark fuscous; irroration, apices of segments, and some hairs in tuft ochreous-whitish. Legs blackish; tibiae and tarsi annulated with white; posterior pair whitish on posterior surface. Forewings triangular, costa arched near base, thence slightly sinuate, apex rectangular, termen slightly bowed, not oblique; blackish mixed with grey and white; markings white; a basal spot; a bar from costa near base uniting with another from costa at $\frac{1}{4}$, to form a fascia, which extends on dorsum from near base to $\frac{1}{3}$, and is sharply toothed posteriorly above dorsum; two suffused spots on dorsum before and after middle, the first larger and produced across disc towards costa; a spot on mid-costa; a narrow fascia from $\frac{3}{4}$ costa to $\frac{3}{4}$ dorsum, posteriorly suffused, anteriorly sharply defined, with a circular anterior process containing a central blackish dot beneath costa; a slender, interrupted, subterminal line; a series of wedge-shaped black marks beyond this, separated in female by some whitish suffusion; terminal edge blackish; cilia blackish barred with white. Hindwings with termen rounded; blackish with a large central orange blotch, sometimes preceded by a small triangular spot near base; cilia orange barred with blackish, on apex and costa blackish. Underside pale orange; forewings with basal patch, oblique median fascia, costal spot and terminal fascia blackish; hindwings with oblique fascia from $\frac{1}{4}$ costa to mid-dorsum, and broad band from costa before middle around apex and termen to tornus.

Tasmania: Cradle Mountain (3,000-3,500 ft.), in January; four specimens received from Dr. R. J. Tillyard.

Fam. OENOCHROMIDAE.

OENOCHROMA LISSOSCIA, n. sp.

λισσοσκιος, smoothly shaded.

♀, 46-48 mm. Head, palpi, and thorax grey. Antennae dark grey. Abdomen grey with a few blackish scales; undersurface reddish. Legs grey, partly reddish tinged; tarsi fuscous. Forewings elongate-triangular, costa bisinuate, apex acute, termen strongly bowed, becoming straight towards tornus; grey with a few scattered blackish scales; some fine fuscous-brown transverse strigulae from basal half of costa; a fuscous-brown suffusion on costa from middle nearly to apex, leaving costal edge for a short distance at about $\frac{3}{4}$ whitish; a fine blackish line from costa shortly before apex to $\frac{3}{5}$ dorsum, outwardly bowed in middle, towards dorsum preceded by a fuscous-brown parallel line, costal half edged posteriorly by whitish, which extends to apex; some grey-brown suffusion on termen, preceded in middle by a suffused blackish spot; cilia fuscous-brown. Hindwings with termen slightly rounded, tornus prominent, rectangular; as forewings but with blackish line antemedian, straight, preceded by a fuscous-brown line, which diverges somewhat towards costa; no subterminal spot. Underside similar; but forewings with a blackish spot on costa near apex, with two blackish dots on veins beneath it, and no brownish suffusion; disc purplish tinged with darker median transverse line; hindwings with a purplish antemedian fascia; posteriorly to this brownish, with suffused reddish subterminal spot between veins 3 and 4.

Exceptional in the genus is that veins 10 and 11 of forewings arise separately from the cell.

Queensland: National Park (3,000 ft), in March; three specimens taken at light.

OENOCHROMA ARTIA, n. sp.

ἀρτιος, perfect.

♂, 38 mm. Crown of head yellow with a dark-reddish anterior line; face whitish. Palpi whitish with a few crimson scales. Antennae brownish-ochreous; pectinations in male $1\frac{1}{2}$. Thorax pale green; bases of patagia yellow; pectus whitish, margin of eyes and forewings ochreous-yellow. Abdomen whitish. Legs whitish irrorated with crimson. Forewings triangular, costa straight, apex pointed, termen nearly straight, oblique; pale green; a yellow line along costa to $\frac{2}{3}$; an oblique yellow line from mid-dorsum, moderately broad, but narrowing to extremity, which lies just beneath $\frac{2}{3}$ costa; terminal edge whitish; cilia pale yellow. Hindwings with termen rounded; whitish; a yellowish suffusion on mid-dorsum giving rise to a short transverse line; a greenish suffusion on dorsum before tornus; a large round brownish-ochreous subtornal blotch; cilia whitish, around tornus yellow. Underside of forewings similar to upperside, but paler and without oblique line; of hindwings greenish-white, tornal blotch anteriorly orange, posteriorly deep crimson.

Western Australia: Dardanup, in October; one specimen received from Mr. G. F. Berthoud. Type in Coll. Lyell.

Gen. Noreia, Wlk.

Noreia loxosticha, Turn. *(Idiodes)*.

I have since received a male example, which shows a small hairy tuft on underside of hindwing over vein 2, and has the posterior tibiae dilated with internal groove and tuft. The species has some close allies in the Indo-Malayan region, and I will not be sure of its distinctness.

Northern Queensland: Kuranda in April and May; two specimens received from Mr. F. P. Dodd.

Gen. Celerena, Walk.

Face smooth. Tongue well developed. Palpi moderate, porrect; second joint shortly rough-haired; terminal joint short, with smoothly adpressed hairs. Antennae rather more than ½; in male shortly ciliated, usually with a small tuft of scales about middle, beyond this with moderately long bristles. Thorax densely hairy beneath, usually with an expansile posterior tuft of hairs. Abdomen of male usually with a basal tuft of long hairs on under-surface. Femora densely hairy. Posterior tibiae of male dilated with inner expansile tuft of hairs, long crooked median spurs, inner terminal spur only, its apex prolonged into a strong outer horny process. Forewings in male with a deep basal furrow beneath in cell: 7, 8, 9 stalked, 10 and 11 stalked, their stalk anastomosing strongly with 12, 10 connected with 8, 9. Hindwings with 5 from above middle of cell, 6 and 7 separate, 8 moderately remote from cell, connected with it by an oblique bar near base.

Type *C. divisa*, Wlk. An Indo-Malayan genus which is rather largely represented in New Guinea.

CELERENA GRISEOFUSA, Warr.

♂, 52 mm. Head yellow. Palpi yellow; apex of terminal joint fuscous. Antennae fuscous; in male minutely ciliated, apical ½ with moderately long bristles (1½). Thorax grey, anteriorly suffused with ochreous. Abdomen grey, sides and under-surface ochreous Legs grey; coxae and undersurface of posterior tibiae pale ochreous; first joint of posterior tibiae with an internal hairy tuft. Forewings triangular, costa straight to ¾, thence arched, apex roundpointed, termen straight, oblique; grey with some yellow suffusion, most marked in costal half of cell; an incomplete narrow yellow fascia from ⅗ costa, outwardly oblique, interrupted in middle, then curved slightly inwards, and not reaching tornus; a band of yellow suffusion posterior and parallel to this; cilia grey. Hindwings with termen gently rounded; yellow; a moderate grey terminal band edged anteriorly by a blackish line and suffusedly prolonged along dorsum for some distance; cilia grey. Underside of forewings dark fuscous with a moderate yellow postmedian fascia not reaching tornus; of hindwings yellow with a dark-fuscous terminal band.

Northern Queensland: Claudie River, in March; one specimen taken by Mr. J. A. Kershaw. Also from New Guinea (Fergusson Island).

THE FLORA AND FAUNA OF NUYT'S ARCHIPELAGO AND THE INVESTIGATOR GROUP.

NO. 4—COLEOPTERA.

By ARTHUR M. LEA, F.E.S., Museum Entomologist.

Contribution from the South Australian Museum.

[Read September 14, 1922.]

PLATE XIII

The small but interesting collection of Coleoptera here dealt with was obtained on the islands by Prof. F. Wood Jones, and presented to the South Australian Museum. As he was specially interested in the mammals, and had but a short time on each island, the time available to collect insects was always small, and those obtained are mostly sand-frequenting species, taken on or near beaches, and usually of wide distribution in Australia; even the new species, at present known only from the islands, will probably be eventually found on the mainland Some of the *Tenebrionidae* were sent to Mr. H. J. Carter, for his opinion, and his descriptions of two new species are incorporated.

CARABIDAE.

Ectroma benefica, Newm. Numerous specimens of a pale variety of this species were obtained in rats' nests on Franklin Island.

Scopodes sigillatus, Germ. Six unusually small specimens were taken on Franklin Island.

Lecanomerus flavocinctus, Blackb. Flinders Island.

STAPHYLINIDAE.

Hyperomma lacertinum, Fvl. This curious wingless species was previously known only from King George Sound. Prof. Wood Jones took one specimen on Franklin Island and Sir J. C. Verco another on St. Francis Island.

SCYDMAENIDAE.

Scydmaenus franklinensis, n sp

♂. Bright castaneous, palpi and tarsi paler. Head and prothorax (except in middle) with fairly long and somewhat golden, or pale reddish hairs, similar but sparser hairs on elytra, but fairly numerous about base; under-surface with short pubescence.

Head rather small; with sparse and small, but (when not concealed by clothing) sharply defined punctures. Eyes small and prominent. Antennae rather long and thin; club four-jointed, its first joint scarcely longer than the preceding one but distinctly wider, apical joint almost as long as two preceding combined. Prothorax moderately long, front parts gently convex, flattened about base, each side of base with a transverse semidouble fovea; with minute scattered punctures. Elytra subovate, widest just before the middle, where they are about twice the width of prothorax, a fairly large impression on each side of base; with sparse, indistinct punctures. Subapical segment of abdomen incurved in middle of apex, the incurvature bounded on each side by a slight projection. Front femora stout, the middle and hind ones pedunculate, front trochanters dentate. Length, 1·25-1·5 mm.

♀. Differs in having antennae shorter, elytra shorter and wider, abdomen simple, front trochanters unarmed, and front tibiae thinner and less curved at the tip.

Hab.—South Australia: Franklin Island (Prof. F. Wood Jones). Type, I. 15360.

Almost the exact size of *S. parramattensis*, but more uniformly coloured, clothing different and club thinner; about the length of *S. brevipilis*, but narrower, club thinner and elytral clothing different. Of the species previously known from South Australia, *S. depressus* is much smaller, with wider elytra, shorter antennae, etc.; *S. griffithi* and *S. fuscipalpis* are much smaller, narrower, and darker, etc., and *S. impavidus* has wider and glabrous elytra, etc. From some directions the hairs appear to form a loose fascicle on each side at the base of the head. When viewed at a right angle the armature of the male abdomen is inconspicuous, but when viewed from in front the projections appear as small subconical tubercles.

DERMESTIDAE.

Dermestes cadaverinus, Fab. Franklin Island.
D. vulpinus, Fab. Franklin Island.

SCARABAEIDAE.

Pimelopus dubius, Blackb. Franklin Island.
P. porcellus, Er. Flinders Island.

TENEBRIONIDAE.

Saragus posidonius Carter, n. sp

Oval, convex, nitid black, oral organs, antennae and tarsi castaneous.

Head finely punctate, antennae with joint 3 half as long again as 4, 8-11 as wide as long; epistoma a little incurved in front. Prothorax moderately convex, subtruncate at apex between the widely rounded anterior angles, foliate margins wide, sides arcuately diverging from apex to base, posterior angles produced and falcate; disc minutely punctate, the foliation concave with a strongly recurved border. Elytra almost as wide as long (9 × 8 mm), convex, horizontal margin moderately wide at base, narrowing at apex; irregularly, coarsely substriate-punctate, both rows, and punctures in rows closely placed, the punctures smaller and sometimes discontinuous near suture, larger and more regular towards sides, each 4 rows bounded by a costate interval, with a less raised and more irregular costa half-way between each of these—the suture also costate—a lateral row of larger punctures, the explanate margins slightly wrinkled. Prosternum and episterna finely pustulose, abdomen striolate. Legs moderately long, tibiae with margins entire, terminal spines short, fore tarsi with basal joints wide. *Dimensions*, 12 × 8 mm.

Hab.—Neptune Island.

Two examples show a species nearest to *S. carinatus*, Breme, but of smaller size and stronger sculpture. In convexity and style of sculpture it is suggestive of *S. brunnipes*, Boisd., but the punctures are coarser, the costae more pronounced, and the foliation of pronotum and elytra wider than in that species. The name suggests its habitat. Type, I. 15356.

Saragus oleatus Carter, n. sp

Pl. xiii., fig. 1.

Widely oval, convex, brilliantly nitid black, oral organs, antennae and tarsi castaneous.

Head minutely, sparsely punctate, epistoma truncate, antennae with joint 3 proportionately shorter than in *posidonius*. Prothorax very convex and mirror like, apex narrowly arcuate, the anterior angles more squarely rounded, the posterior more acute, the foliate margins narrower and more deeply hollowed, the sides less strongly arched, the recurved border considerably thicker than in the preceding species; disc submicroscopically punctate. Elytra nearly as wide as long (8 × 7¼ mm.), very convex, lateral margin narrower than in the preceding; coarsely and unevenly striate-punctate, the 4 sutural rows of large punctures on each tending to confluence, rows 5 and 6, also 7 and 8, delimited by three costate intervals; beyond these the seriate punctures uneven in size, the intervals irregularly convex, the suture carinate throughout; a lateral row of large punctures. Prosternum finely pustulose at sides, abdomen striolate. Legs shorter than in *S. posidonius*. *Dimensions*, 11 × 7¼ mm.

Hab.—Pearson Island. Type, I. 15357.

I have examined three examples of this species, which is more closely allied to *S. brunnipes*, Boi , then the preceding, but with a similar style of sculpture. It is remarkable for the apparently highly *varnished* surface, its polished and convex pronotum, coarsely punctate elytra with its irregular series and costate intervals Wider and more convex than *S. brunnipes;* it is narrower and less convex than *S. sphaeroides* and *S. frenchi.*

Saragus brunnipes, Boi. Four specimens from South Neptune Island represent a rather coarsely punctate variety of this species. The species was also taken on Black Rocks.

Pterohelaeus simplicicollis, Blackb. One specimen from Franklin Island, and another from St. Francis Island, identified by Mr. Carter as probably belonging to this species.

P. nitidissimus, Pasc. A single specimen from Flinders Island noted by Mr. Carter as having seriate punctures on elytra a little larger than on the typical form.

P. ovalis, Blackb. St. Francis Island.

Helaeus modicus, Blackb. A very interesting series of 33 specimens was taken on Franklin Island, ranging in length from 18 to 25 mm. Of these 14 have the curved portion on the left of the apex of the thorax on top of the right portion, and 16 have the right on top of the left; the difference is not sexual; on three the curved parts do not touch, being separated about half a millimetre. The species was also taken on Goat Island (pl. xiii., fig. 2).

H. castor, Pasc. Franklin Island.

Brises duboulayi, Bates. Franklin Island.

Micrectyche nana, Pasc. A specimen from Franklin Island, identified by Mr. Carter as probably belonging to this species.

Caediomorpha heteromera, King. Black Rocks, St. Francis, Flinders, and Franklin Islands.

Hyocis bakewelli, Pasc., var. *pallida*, Macl. St. Francis Island.

Trachyscelis ciliaris, Champ. Franklin, Eyre, and Flinders Islands.

Cestrinus aspersus, Blackb. Franklin Island.

ANTHICIDAE.

Anthicus strigosus, n. sp.

Pl. xiii., fig. 3.

Head and prothorax dark reddish-brown, elytra almost black, legs, antennae and palpi more or less reddish, tarsi paler. Elytra moderately clothed with pale, subdepressed pubescence.

Head moderately large, parallel-sided for a short distance behind eyes, and then hind angles rather strongly rounded; with crowded and small punctures, many of which are longitudinally confluent; with a narrow and continuous shining median line. Eyes small, medio-lateral and very prominent. Antennae rather long Prothorax very little longer than wide, sides strongly rounded, but suddenly narrowed near base; densely and finely longitudinally strigose. Elytra elongate-elliptic, shoulders completely rounded off; with not very dense and rather small, but sharply defined punctures, becoming very small posteriorly. Legs moderately long. Length, 2-2·25 mm.

Hab.—South Australia: Port Lincoln (Rev. T. Blackburn), Eyre Island (Prof. F. Wood Jones). Type, I. 15278.

The prothorax is deeply striated and the head has a shining median line as in *A. intricatus*, but it is larger than that species and very differently coloured; the elytra at first appear to be uniformly coloured, but in certain lights the base and a postmedian space appear to be very feebly diluted with red. The apical half of the femora is darker than the basal half, on the specimen from the island being distinctly infuscated. The species is probably apterous.

A specimen from the Swan River (taken by Mr. J. Clark from a tussock of grass) probably represents a variety of the species; it differs from the type in having the head and prothorax paler (of a rather dark blood-red colour) and the elytra uniformly pale castaneous; the median line on the head is narrower (it almost vanishes in its middle), the elytral punctures are larger, and the elytral pubescence is longer and more upright.

CURCULIONIDAE.

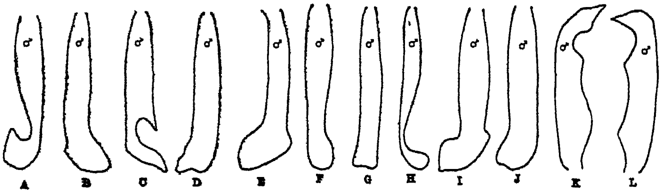
Timareta crinita, Pasc. Numerous specimens, agreeing well with others from Western Australia, were obtained on Flinders and St. Francis Islands. On many of them the prothorax has denser scales, forming a fairly conspicuous vitta near each side; on the elytra the scales are condensed into numerous spots, elsewhere they thinly cover the surface and they are often absent from about the punctures, in consequence the elytra to the naked eye have a distinctly spotted appearance, although the scales are nearly always of a snowy whiteness (except that on the suture they are slightly darker), the place just beyond the incurved portion of the hind tibiae of the male is more densely clothed with long hair than elsewhere, and the middle of the incurved part appears very thin from some directions

Timareta hamata, n. sp.

Pl. xiii., fig. 4.

♂. Black, antennae and tarsi reddish. Densely clothed with small round greyish scales, closely adpressed to derm, and with numerous irregular whitish spots; with numerous pale, suberect setae on prothorax, and forming a regular line on each elytral interstice, sides and legs with longer hairs.

Head with dense normally concealed punctures. Antennae long and thin, scape the length of front tibiae. Prothorax slightly longer than wide, sides strongly rounded, apex narrower than base, with dense normally concealed punctures. Elytra with shoulders strongly rounded, sides widest at about basal fifth, thence almost evenly narrowed to apex; with regular rows of large punctures, appearing much smaller through scales; interstices with dense and minute normally concealed punctures. Under-surface with dense punctures of two sizes, the larger ones scarcely concealed; abdomen with basal segment widely concave in middle. Front tibiae arched near apex, the apex triangularly dilated on inner side; hind tibiae narrowed near apex, but apex itself much thickened and hooked, with a conspicuous fascicle of long hairs on tip of the hook. Length, 6-7 mm.



A B, Hind tibiae of *Timareta hamata*, Lea, from two points of view and unclothed; C D, *T. incisipes*, Lea; E F, *T. pilosa*. Blackb.; G H, *T. crinita*, Pasc.; I J, *T. figurata*, Pasc.; K L, front tibiae of *T. incisipes*, Lea.

♀. Differs in being wider and more convex, antennae shorter, seriate punctures of elytra smaller, basal segment of abdomen gently convex, front tibiae shorter and scarcely arched near apex, hind tibiae shorter and thicker, apex itself wider but not hooked or fasciculate.

Hab.—South Australia: Flinders Island (Prof. F. Wood Jones). Type, I. 15256.

At first glance apparently like small specimens of *T. pilosa*, but at once distinguished by the hind tibiae of the males (compare figs. A B with E F). *T. pustulosa* has somewhat similar ones, but the front tibiae are less swollen towards base and the elytra are very different. Parts of the under-surface and of the femora and tibiae are more or less obscurely reddish on some specimens, but on most of them those parts (except as to their clothing) are black or blackish. The white spots are most numerous on the sides and apical slope of the elytra, where they are often accentuated by the adjacent scales being more or less sooty; on the prothorax the white scales usually form a distinct stripe towards each side, and parts of a median line, on the head and rostrum the scales are usually entirely white; on some specimens some small patches of scales are shining.

Timareta incisipes, n. sp.

Pl. xiii., fig. 5.

♂. Black or blackish, antennae and tarsi reddish. With dense, small, round scales closely adpressed to derm; with numerous subdepressed setae on prothorax, and forming a regular row on each elytral interstice.

Head, prothorax, elytra, and under-surface as described in preceding species. Front tibiae trisinuate on lower surface, the sinus near apex appearing as a conspicuous notch; hind tibiae with a deep notch near apex, the notch with long hairs about it. Length, 5-6 mm.

♀. Differs in being rather more robust, antennae and legs shorter, tibiae not notched and abdomen convex.

Hab.—South Australia: St. Francis, Eyre, and Franklin Islands (Prof. F. Wood Jones). Type, I. 15257.

The body parts of this, the preceding species, and of *T. crinita* and *T. pilosa* are much alike, and the females are difficult to satisfactorily distinguish; but the males may be quickly identified by the hind tibiae alone; on the present species the front tibiae as well as the hind ones, are notched. On several specimens the under-surface, tibiae, and even occasionally the elytra, are obscurely reddish. The scales are scarcely alike on any two of the 18 specimens before me; they are usually of a pale slaty-brown, with more or less large patches, or numerous sooty spots, interspersed with white or bluish-white spots; on the prothorax the white scales form irregular lateral vittae; on an occasional specimen the scales are mostly sooty-brown, with numerous bluish-white spots; on one they are whitish obscurely mottled with pale brown; on two specimens many of the scales have a soft golden lustre; many specimens have an ochreous spot on the forehead. The setae on the shoulders are longer than on other parts of the elytra, but they are not of the great length of some of the sand-frequenting species. The tibiae of both sexes are each tipped with a conspicuous comb-like fringe of setae, as they are on most species of the genus.

Otiorhynchus cribricollis, Gyll. Black Rocks.

Mandalotus tenuicornis, Lea. Black Rocks.

M. ventralis, Blackb. Flinders Island.

Perperus languidus, Er. Flinders Island.

Zephryne, sp. One specimen of a species evidently near *Z. geometrica* was obtained on Franklin Island; but as the colours of species of the genus vary considerably, it is not desirable to name an unique.

Desiantha maculata, Blackb. St. Francis Island.

Eloeagna squamibunda, Pasc. St. Francis and Franklin Islands.

Halorhynchus caecus, Woll. Two specimens of this curious little blind species were taken on Flinders Island; it was named originally from Western Australia, but has been taken on Kangaroo Island and on beaches near Adelaide.

Pentarthrocis, n gen.

Head rather small. Eyes very small, composed of a few coarse facets. Rostrum moderately long, slightly incurved between base and insertion of antennae, in front of antennae slightly wider and parallel-sided. Antennae rather short; funicle the length of scape, first joint slightly longer than second and third combined, third shortest of all; club indistinctly jointed. Prothorax rather elongate, sides gently rounded, base wider than apex. Scutellum invisible. Elytra elongate, with rows of large punctures in regular striae. Metasternum elongate. Abdomen with third and fourth segments very short, the others large. Legs rather stout; front tibiae with small subapical spur, and large terminal hook; tarsi with third joint moderately dilated, the clawjoint rather long and thin.

Of the Australian genera with the funicle five-jointed the present genus is distinguished from *Cossonideus* by the small eyes; *Halorhynchus* is blind; *Pentamimus* and *Pentarthrum* have much shorter rostrum with much larger eyes; *Conlonia* has thinner rostrum, more parallel-sided body, and seriate arrangement of the elytral punctures (themselves much smaller) scarcely in evidence; and *Microcossonus* has much larger eyes, scutellum conspicuous, etc. In catalogues it should be placed near *Pentarthrum*. The only known species has somewhat fusiform outlines, and straggling hairs on the sides; its rostrum has a slight resemblance to that of some species of *Cossonus*.

Pentarthrocis ammophilus, n. sp.

Pl. xiii., fig. 6.

Dark piceous-brown, elytra sometimes dark castaneous. Some long straggling hairs on sides of prothorax and of elytra, and some shorter ones on under-surface and legs.

Head smooth, convex, and with sparse and minute punctures. Rostrum about twice as long as its apical width; with rather sparse and small but distinct punctures, becoming more numerous about apex. Prothorax with sides evenly rounded and gently increasing in width from apex to about basal fourth, and then decreasing to base; with sharply defined, fairly large and numerous but not crowded punctures on upper-surface, denser and larger on sides. Elytra at base wider than base of prothorax, shoulders strongly rounded, sides gently rounded and widest at about middle; with rows of large, regular punctures, in rather deep striae; interstices evenly convex, and each with a row of minute punctures. Sterna and two basal segments of abdomen with coarse punctures, smaller and more crowded on apical segment, and absent from the third and fourth. Length (excluding rostrum), 2·75-3·25 mm.

Hab.—South Australia: St. Franics Island (Prof. F. Wood Jones); Western Australia: Geraldton (A. M. Lea). Type, I. 15304.

Some specimens are almost uniformly coloured throughout, but on others the elytra, club, and sometimes parts of the legs are slightly paler. On the male there is a wide shallow depression on the two basal segments of abdomen, on the female those segments are flat in the middle. All the specimens were obtained at the roots of beach-growing plants.

COCCINELLIDAE.

Scymnus flavifrons, Blackb. One specimen taken from a rat's nest on Franklin Island.

Rhizobius ruficollis, Blackb. Black Rocks.

DESCRIPTION OF PLATE XIII.

Fig. 1. *Saragus oleatus*, Carter.
,, 2. *Helaeus modicus*, Blackb.
,, 3. *Anthicus strigosus*, Lea.
,, 4. *Timareta hamata*, Lea.
,, 5. *T. incisipes*, Lea.
,, 6. *Pentarthrocis ammophilus*, Lea.

CYLINDRO-CONICAL AND CORNUTE STONES FROM THE DARLING RIVER AND COOPER CREEK.

By Robert Pulleine, M.B., Ch.M.

[Read September 14, 1922.]

Plate XIV.

Literature.

Apart from a few records of exhibition of single specimens of these stones at scientific meetings, the first extended account is by:—

1. Walter R. Harper, "A Description of Certain Objects of Unknown Significance formerly used by some New South Wales Tribes" (Proc. Linn. Soc. N.S. Wales, vol. 23, 1898, pp. 420-436, pls. xii.-xviii.).

2. R. H. Mathews, L.S., contributed a paper to Section F at the Brisbane meeting of the Australian Association for Advancement of Science, 1909, entitled: "Some Rock Pictures and Ceremonial Stones of the Australian Aborigines" (Proc., pp. 493-498).

3. Robert Etheridge, jun., in the Memoirs of the Geological Survey of New South Wales, Ethnological Series, No. 2, on "The Cylindro-Conical and Cornute Stone Implements of Western New South Wales and their Significance" (pp. 1-41, pl. ix.), gives a full account of all known to that date on the subject, with an analysis, illustrations of many specimens, and a map of distribution.

4. Eylmann, "Die Eingeborenen der Kolonie Südaustralien," taf. xxxi., f. 1910, figures a single specimen from Cooper Creek with short reference.

The early explorers of New South Wales do not mention these stones, and it is especially singular that neither Howitt nor Gason, who wrote exhaustively on the natives of the areas in which these objects occur, refer to them in any form. Howitt's great work is so exhaustive that if anything had been known about the use of these stones it would certainly have not escaped his notice.

Mr. Simpson Newland, who lived on the Paroo River from 1861 to 1876, tells me that the stones were present on his station, but that the natives, then very numerous, took no notice of them, neither using them nor avoiding them in any way, and had no name for them.

Mr. John Conrick, of Nappa Merrie, Cooper Creek, where several have been found, tells me that, although he has lived there since the early seventies, he has never seen them used or noticed by natives, and that they are known there simply by the name of "Moora." Now the word "Moora," in Gason's Vocabulary of the Dieri of Cooper Creek, gives the meaning as Creator or Good Spirit, and as "Moora Moora" is frequently mentioned in legends (recounted by Howitt), Sir J. G. Fraser, in his "Totemism and Exogamous Marriage," vol. 1, points out that Gason's meaning is erroneous, and that "Moora Moora" were "nothing more than the legendary predecessors or prototypes of the Dieri," comparable to the Alcheringa ancestors of the Arunta of Central Australia.

The significance of the foregoing seems to be that the objects in question are of such antiquity that their origin and use are lost in the past, as regards the present aborigines, and that any explanations they try to give are purely imaginary. Such explanations as these:—(1) Of use in tooth avulsion ceremonies (3, p. 14); (2) as a fetish to procure a good supply of snakes, given to Gregory (3, p 14); (3) ceremonial use in connection with nardoo harvest (2, p. 497); (4) bora message stones (3, p. 12), show what various accounts aborigines will give in their desire to impart information. I think, therefore, that we may conclude that the aborigines have no knowledge, even traditional, of the origin and uses of the objects in question. Etheridge (3) carefully considers the ten suggested uses and narrows the probabilities down to one or two.

GENERAL DESCRIPTION.

At present some two to three hundred of these stones exist in Museum and other collections in Australia, besides many reported to have been sent to Germany from Menindie some years ago. There is no note of them in available German ethnological literature.

They are all of the same character—cylindrical from 5 to 30 inches in length, mostly cupped at the base and composed of clay, kopi, sandstone, slate, or hard quartzite. Some are curved to form the Cornute form. The raw material from which they have been shaped comes from the outcrops at some distance from the alluvial area where they are mostly found, on claypans or in the blown sandhills. Sir Douglas Mawson says, for instance, that the slate must have come from as far away as Cobar or Broken Hill. Those of kopi are made from gypsum, with or without an admixture of clay, and are sometimes quite friable on the surface. The section is nearly always approximately circular.

MARKINGS.

A large proportion of the stones examined present markings, especially the softer ones. The hard quartzite specimens seldom, or never, exhibit them. The most common form of marking is what we might call "tally marks"—small incisions, single, in pairs, threes, or in linear series. There may be as few as six, or as many as several hundreds. In one specimen (1, pls. xiii. and xiv.) linear series of these marks have been scored through by paired, parallel, longitudinal marks, while other series are unscored. It is hardly to be doubted that these are actually tallies recording a number of objects or events. The keeping of tallies for various purposes is well known as occurring amongst Australian aborigines, and not unknown even amongst Europeans. "Broad arrow" marks occur, and it is highly probable that these, as in rock carvings and paintings, indicate emu feet or even tracks [see illustration of rock carvings on Burnett River (2)]. Their use on the cylindrical stones is a mystery, unless we consider them the most frequent and most easily executed form of aboriginal decoration.

Circular markings may occur along the length of the stone, or several may be present at the pointed end [fig. 1, the Praeputial Rings" of Etheridge (3)]. These, apart from the hooks and stars (1, pl. xiii.), certainly variants of the emu track marks, exhaust the forms of sculpture observed on the cylinders.

Now the assigned uses of these stones are many and various, and have been discussed at length by Etheridge (3, pp. 3-18). He dismisses them all except one, or possibly two, as untenable. While on the slender evidence admitting the possibility of the snake-fetish theory, he holds the Phallic theory to be more tenable, in which view he is supported by the authority of the late Sir Edward Stirling, F.R.S., and Prof. J. W. Gregory. While direct evidence is unfortunately wanting, and Gason in his account of the circumcision ceremony of the Dieri tribe expressly omits details, he would certainly have mentioned objects so striking if they had been in common use. It would be well if we could follow up this theory and see if there is any indirect evidence to support it. The shape of the stones is at least suggestive, and Phallicism is a widespread cult among primitive peoples, the world over, and not unknown in higher civilizations.

Schliemann, in Ilios, figures several objects in stone and marble found during excavations at ancient Troy, which he supposes to be phalli or priapi. One of those figured on p. 452, No. 682, bears a striking resemblance to the one figured (fig. 1), even to the praeputial rings. The likeness may only be accidental, and the marble object of the ancient Trojans may have been misidentified, still I mention the striking resemblance for what it is worth. An objection may be raised that the cult would have been universal in Australia and not confined to the central eastern area, but against this we have the localized Alcheringa cult with its equally striking stone churinga spread over a smaller area.

If we accept the views of Churchward, now gaining the attention of anthropologists, that mankind originated in the great lake districts of Africa, we find opened up a path which leads to an understanding of the origin of our aborigines and their beliefs. In his two books, "Signs and Symbols of Primordial Man" and "The Origin and Evolution of Mankind," he pictures the Pygmy exodus throughout the world and their displacement and annihilation by the people of the second Nilotic exodus to which our aborigines, according to him, belong. He states that the Pygmies of the first Nilotic invasion were displaced in Australia and eventually only remained in Tasmania.

The recent discovery of plateau implements in Central Australia by Professor Howchin (Trans. Roy. Soc. S. Austr., vol. xlv., 1921, p. 206, pls. xi. to xxi.), and also by Mr. Campbell at Millar Creek, strengthens this view, and the remarkable legend told in Mr. Simpson Newland's book, "Paving the Way," chap. xi., "The Doom of the Mullahs," may be the traditional account of the fall of the Pygmies in Australia. At any rate, Professor Krause thought it of sufficient importance to give an account of the legend in the Zeitschrift für Ethnologie of the Berliner Anthropologische Gesellschaft, vol. 34, 1902, p. 263.

The Pygmies who still live in Africa, New Guinea, and elsewhere are a non-totemic people, and seem by isolation to have retained their purity. This throws a new light on the anthropology of the extinct Tasmanians, who had the true peppercorn hair of the Pygmies, no totems, and no boomerangs. The second Nilotic exodus brought the boomerang, a very ancient weapon in Egypt (*vide* Horus I. holding in left hand a boomerang, Book of the Underworld), also at Deirel Bahari a statue of a Prince of Punt carrying a boomerang (*vide* Churchward, "Origin and Evolution of Mankind"), and with it the signs and symbols of the Nilotic people and their palaeolithic stone implements.

Now the Phallic Cult originated in Egypt, where it was identified with the God Osiris, and from thence it was carried all over the world, was elaborated later by the Greeks and Romans, and crops up to-day in the maypole and the ceremonials of the Lingayat Sect, in Southern India (*vide*

Lingayat, "Castes and Tribes of Southern India," vol. iv.). The whole account of the origin and spread of the cult is to be found in Rolle, Recherches sur le "Culte de Bacchus," Paris, 1824, vol. i., p. 2. Now, in the light of this it is not improbable that the people of the second Nilotic exodus brought this rite with them, not necessarily associated with the ceremonial of circumcision, for in the area where the cylindro-conical stones are commonest circumcision was not practised by the aborigines in modern times. What may have been the condition in ancient times we shall never know, but I suggest that it is by following up this clue that our efforts of gaining further knowledge of the matter are most likely to be rewarded. The whole subject is bound by the difficulty of visualizing the enormous antiquity of man and his wanderings in prehistoric times.

DESCRIPTION OF PLATE XIV.

Fig. 1. Upper third of cylindro-conical, made of kopi, showing "praeputial rings" of Etheridge. Nat. size

Fig. 2. Phallus or priapus, from Schliemann, Ilios, p. 452, No. 682, for comparison with fig. 1.

Fig. 3. Portion of cylindro-conical of slate, showing "tally-marks."

AUSTRALIAN COLEOPTERA
PART III.

By ALBERT H. ELSTON, F.E.S

[Read September 14, 1922.]

HALIPLIDAE.

I was asked to investigate the question, regarding the number of joints in the antennae of the *Halipli,* by Mr. Sloane, to whom I desire to express my thanks for specimens of exotic species, and for his kindly advice and suggestions.

I had already prepared a drawing and notes on *Haliplus ruficollis*, De Geer (Germany), when I heard from Mr. Sloane that Dr. Frits van Emden had already published a paper (Entomologische Mitteilungen, Band xi., Nr. 2, 15 Marz, 1922) with a drawing and a description of an antenna of this insect, and, as I have been able to dissect joint 1 from its socket in the head, I thought it desirable to publish this drawing in addition to the antenna of *H. testudo*, Clark (Australia). With both of the above species I was able with relaxed specimens to move each of the individual eleven joints separately, the basal joint moving quite freely in its socket in the head.

In addition to those names already mentioned by Dr. van Emden, we find in the following publications the antennae of the Haliplidae referred to as having ten joints:—Lacordaire, vol. i., p. 411 *(Haliplus)*, "Antennes courtes, de 10 articles: 1 petit, 2-9 obconiques subégaux, 10 plus long, terminé en pointe." Kraatz, Insecten Deutschlands, p. 9 (Haliplini), "Antennae frontales, decemarticulatae." Sharp, Cambridge Natural History, vol. ii.. p. 209, "Antennae bare, ten-jointed." Packard, Guide to the Study of Insects, p 436, "In *Haliplus* the antennae are ten-jointed." Rye, British Beetles, p. 62 *(Haliplus)*, ". . . their antennae are ten-jointed." Sharp, in the Biologia Centrali-Americana, vol. i. (2), gives a figure of *Haliplus solitarius* (pl. i., fig. 1), but in the description on page 2 does not even mention the antennae. Stephens, Manual of British Beetles, p. 61, speaking of *Haliplus*, says, "antennae ten-jointed."

Apparently all these writers had regarded the two basal joints as one, the first division being considered the "bulb of insertion," similar to that found in the Carabidae. The insects comprising the genus *Haliplus* have no bulb to the first joint (fig. 1, a and c), which is inserted into the head and moves freely in its socket (fig. 1, b), and joint 2, in turn, articulates on joint 1. For the purpose of comparison a drawing is given of an antenna of a carab, *Lebimorpha benefica*, Newm. (fig. 1, d), showing the bulbous basal part of joint 1; on the first joint of each antenna is to be seen a long tactile seta situated in the middle before the apex.

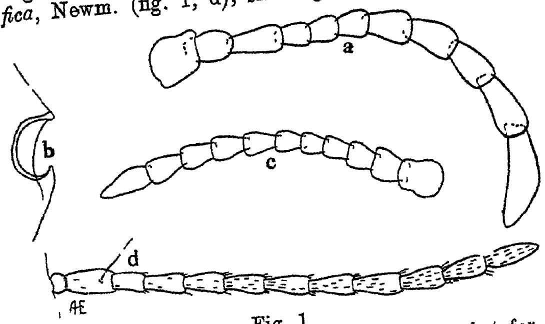


Fig. 1.

a, Antenna *Haliplus ruficollis*, De Geer; b, socket for reception of antenna *H. ruficollis*; c, antenna *H. testudo*, Clark; d, antenna *Lebimorpha benefica*, Newm.

PAUSSIDAE.

Arthropterus articularis,(1) Elston.

The length of this species should read 9-9·5 mm., not 5-5·5 mm., as printed.

HISTERIDAE.

Chlamydopsis epipleuralis, Lea.

Five specimens of this species were taken by R. F. Kemp and myself from the nest of the common small black ant (*Iridomyrmex*, sp.), in the Mount Lofty ranges. They are variable in size, ranging from 2·5 to 4 mm. in length; the smallest is much paler than the typical form, its colour is testaceous, with parts of the elytra almost flavous.

COLYDIIDAE.

Todima fulvicincta, n. sp. (Fig. 2).

Elongate; piceous, with clypeus, antennae, sides of prothorax, portions of elytra, and parts of legs, fulvous. Scantily clothed with short, golden hairs, fairly numerous on front of prothorax, and on the elytra arranged in rows towards apex. Under-surface nitid, piceous, except forepart of head and sides of prosternum, which are fulvous; sparsely clothed with short, depressed, golden hairs.

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(1) Elston, Trans. Roy. Soc. S. Austr., 1919, p. 342.

Head subquadrate, anterior margin and sides near the middle contracted, with a shallow, elongate depression near base of each antenna; and with dense, small, subrugose punctures. Antennae about four-fifths the length of head, moderately robust, second joint approximately twice the length of the first, joints 4 to 8 little more than half the width of the second, and not quite as long, the ninth wider than the eighth, the tenth more than twice as wide as the ninth and almost semicircular in shape, the apical longer than and about three-quarters the width of the tenth, almost circular.

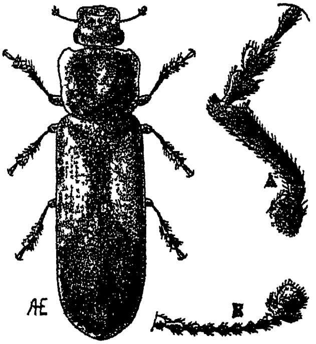

Fig. 2.
Todima fulvicincta, n. sp. A, front leg. B, antenna.

Prothorax about one and half times wider than head, the anterior margin wider than the base, sides contracted near the middle, the anterior angles acute, posterior ones rounded, disk with a large, shallow, obovate depression, and divided transversely with a more or less distinct raised portion; with dense, subrugose punctures, larger and more distinct than those on head. *Scutellum* very small and somewhat semicircular. *Elytra* at base slightly wider than prothorax, and about three times as long, sides parallel to beyond the middle, and evenly rounded towards apex; with closely placed seriate punctures, larger than those on prothorax. *Legs* robust, first two joints of tarsi dilated. Length, 3·5-4·5 mm.

Hab.—South Australia, taken in *Xanthorrhoea* on the summit of the Devil Peak, near Quorn (R. F. Kemp and A. H. Elston). Type, in author's collection; co-type, I. 15232, in South Australian Museum.

A very distinct species, and easily distinguished by its markings. The fulvous part on the prothorax is widest in front, sometimes disappearing before base, and on each elytron is in the form of a crescent, the convex side reaching a little more than half-way across, between the margin and the suture; this crescent-shaped part varies somewhat in size on the twenty-two examples before me; a narrow edge at the apex of the elytra is also fulvous, and on most specimens is joined to the crescent-shaped patch with a very narrow strip at the margins. The head and prothorax are in parts shagreened owing to the density of the punctures. The femora and tibiae are brown, in parts paler, the base and apex of the latter, and the tarsi are fulvous. A more robust species than *T. lateralis*, Blackb., with the shape of the prothorax very different, the punctures on the elytra larger, and the two first joints of the tarsi more dilated.

CLERIDAE.

Phlogistus agraphus, n. sp.

Upper-surface piceous, subnitid, apendages of mouth and the antennae testaceous, club of latter infuscated, head in parts reflecting blue, legs dark blue to piceous. Clothed with moderately long griseous hairs, thicker at the sides of prothorax than elsewhere. Under-surface green, with brassy reflections, and scantily clothed with griseous hairs.

Head with a distinct, round, moderately deep fovea between the eyes, and with closely-set, somewhat deep punctures, more or less rugose towards forepart. Antennae reaching to about middle of prothorax, joints 9 and 10 transverse, the eleventh ovate-acuminate. *Prothorax* transverse, the anterior margin wider than the basal one, before apex with a curved, and at the base with a straight transverse impression, the centre of disc with a moderately deep depression, in the centre of which is a tolerably long, deep furrow, the sides are strongly rounded, the greatest distance between them near the middle; with somewhat dense punctures, about same size as those on head but more feeble, transversely rugose on disk and sides. *Elytra* at base distinctly wider than prothorax, and about twice as long as wide, sides parallel to beyond the middle, then gently rounded off towards apex; with ten rows of large, deep, quadratic punctures, which start from behind the base and extend to about the apical quarter of elytra, the apical fourth with rows of almost obsolete punctures. *Legs* robust, posterior femora almost reaching apex of abdomen. Length, 9·5-11 mm.

Hab.—Western Australia: Cottesloe (H. M. Giles); Perth (J. Clark). Type, in author's collection; co-type, I. 15337, in South Australian Museum.

A very robust species; on some specimens the greenish reflections on the elytra are stronger than on others; on the elytra the basal and apical portions are more nitid than the remainder, the large seriate punctures suddenly cease at the apical fourth, then continued, only very feebly, in rows to the apex. In sculpture it comes nearest to *Ph. imperialis*, Gorham, but differs in being more robust, in the shape of the prothorax, the punctures on same more feeble, the basal part of elytra more tumid, and the punctures on elytra somewhat larger.

Phlogistus rubriventris, n.sp.

Shining black, palpi, apical joint of antennae and tarsi slightly diluted with red, the abdomen and tarsal claws red; moderately clothed with pale hairs, semi-erect on the uppersurface and depressed underneath.

Head somewhat elongate; with a large, round, interocular depression, and dense punctures, which are individually distinct on the top of head, but smaller and more rugose towards the forepart. Antennae reaching to about the middle of prothorax; club three-jointed, ninth joint obconical, tenth almost transverse, and the eleventh ovate-acuminate. Prothorax transverse, before the anterior margin with a curved, and at the posterior one with a straight transverse impression, a moderately deep fovea on the disk, situated immediately behind the anterior transverse impression, and a shallow depression at each side near the middle; the lateral margins are well rounded, the greatest width between them being near the middle; less closely punctured than the head, the punctures are somewhat scattered on the disk, but at the sides they are closer and more or less rugose. *Elytra* at base much wider than the prothorax, about twice as long as wide, sides almost parallel and gently rounded off towards apex, shoulders prominent; with ten rows of moderately large, almost quadratic, punctures, which begin at the base and extend to the extreme apex. *Legs* comparatively short, the posterior femora not reaching the apex of elytra, claws moderately long, with a conspicuous tooth, situated on the inside near the middle. Length, 7-8·5 mm.

Hab.—Western Australia: Eradu (J. Clark). Type, in author's collection; co-type, I. 15338, in South Australian Museum.

This species is very distinct from any other *Phlogistus* known to me, the very conspicuous median teeth on the claws made me, at first, feel doubtful as to it being a *Phlogistus*, but on examining the claws under a moderately high power, I find that these teeth appear to have their origin at the base of the claws. The punctures at the base, on the shoulders, and towards the apex of elytra are slightly smaller than those on the disk, but nevertheless, are very distinct, the extreme apex of elytra is truncate, and at the sutural angle somewhat acuminate. A specimen from New South Wales, in the collection of Dr. E. W. Ferguson, is possibly a variety of this species; it differs from the type in having the palpi and antennae pale, the apical joint of the latter more elongate;

the prothorax is somewhat differently shaped, in *rubriventris* the anterior and posterior margins are about equal in length, but in the New South Wales specimen the anterior margin appears to be wider, also the surface of the prothorax is less nitid, not so uneven, and with more feeble punctures; otherwise it agrees very well with the above description.

Phlogistus ungulatus, n.sp.

Black, subnitid, antennae and appendages of mouth brownish, claws reddish. Somewhat thickly clothed with pale hairs, more or less shaggy on the upper-surface and depressed on the under-surface.

Head with a shallow longitudinal impression near the base of each antenna, and with small, shallow punctures, somewhat scattered on the top, but towards forepart closer, and more or less rugose. Antennae short, barely reaching to middle of prothorax, club three-jointed, joints 9 and 10 transverse, the apical almost as long as the two preceding combined and obtusely pointed. *Prothorax* barely transverse, behind the anterior margin and at the base with comparatively shallow transverse impressions; a feeble longitudinal impression on the disk, situated immediately behind the anterior transverse one, and on each side near the middle of the lateral margin a round depression; the punctures are somewhat more feeble than those on the head, and rugose at the sides. *Elytra* at the base distinctly wider than prothorax, and about twice as long as wide, sides parallel to beyond the middle and then gently rounded off towards apex; with ten rows of moderately deep and almost quadratic punctures, starting at the base and reaching to the extreme apex. Posterior *femora* do not reach apex of elytra, the basal teeth on the claws very long and conspicuous. Length, 4·5-5·5 mm.

Hab.—Western Australia: Swan River (J. Clark). Type, in author's collection.

Very closely related to the preceding species but easily distinguished from it by its smaller size, the whole of the under-surface is black, more hairy, and the punctures, particularly on the prothorax, are more feeble, and with apex of each elytron rounded. The peculiar structure of the claws readily distinguishes this, and the preceding species, from all previously described ones, the basal teeth on the claws of the present species are very elongated, nearly extending to the apex of the claw, and giving it the appearance of being cleft.

Phlogistus leucocosmus, n.sp.

Upper-surface subnitid, blue, antennae and apendages of mouth more or less testaceous, head greenish-blue, elytra almost violet, clothed with somewhat shaggy pale hairs, very densely arranged near middle of elytra, and forming an oblique fascia on each. Under-surface greenish-blue and rather scantily clothed with pale, depressed hairs.

Head wide, with a large round interocular depression and close rugose punctures. Antennae moderately long, reaching to beyond the middle of prothorax, joints 9 and 10 obconical, the eleventh ovate-acuminate. *Prothorax* almost as long as wide, before the apex with a curved, and at the base with a straight transverse impression, the latter deeper than the former, the disk with a deep round depression, the top of which touches the anterior transverse impression, sides well rounded, the greatest distance between them being near the middle; middle of disk with fine transverse wrinkles, the punctures only individually distinct near apex and sides. *Elytra* at base wider than prothorax and about twice as long as wide, sides almost parallel to beyond the middle then gently rounded off towards apex, humeral angles prominent, with ten rows of moderately large punctures, which begin from behind the base and end abruptly at the median fascia of hairs, the base with only a few small, scattered punctures, the posterior part behind the fascia with disjointed rows of obsolete punctures. Posterior *femora* do not reach apex of posterior part of body. Length, 6·5-7 mm.

Hab.—Western Australia· Swan River (J Clark). Type, in author's collection.

A very distinct species, and readily distinguished by the oblique fascia of pale hairs near the middle of the elytra. On one specimen the head is green with brassy reflections, and underneath the fasica of hairs there are traces of green. The sculpture of the elytra is very similar to that of *Ph. mundus*, Blackb., but is distinguished from it by its colour and the elytral fascia, the shape and puncturation of the prothorax is also different, and the eyes are somewhat more prominent.

PHLOGISTUS PUNCTATUS, Hintz.

A specimen from Bowen, Queensland, agrees very well with the author's description, except that the whole of the antennae are testaceous, the labrum, anterior and intermediate legs are also of the same colour, the two latter have their knees infuscated, the posterior tibiae on the under-surface are pale The sutural row of punctures begins almost immediately behind the scutellum.

TARSOSTENUS UNIVITTATUS, Rossi..

Opilo incertus, Macl.

Macleay's name will now have to be added to the several synonyms of this cosmopolitan species. There are specimens of it in my collection from Queensland, South Australia, and Western Australia, and they are, *inter se*, variable both in size and colour. A specimen from South Australia is much paler than the typical form, its colour is a reddish-brown with the head almost black, and the fascia on the elytra yellow; on some the whole of the legs are ferruginous, here and there infuscated.

Tarsostenodes leucogramma, n sp.

Elongate; testaceous, with a spot on each elytron near the scutellum, a larger one below each of these, the posterior half of elytra, and parts of the legs, bluish-black or black; a little behind the middle of elytra are two raised white bands obliquely placed, touching the margins but not the suture, midway between these and the humeral angles, near but not touching the margins, two raised white maculae, and about midway between the latter, near the base but not touching the suture, two similar, but somewhat smaller, maculae. Clothed with moderately long, semi-erect, black hairs, those on the posterior part of elytra are thickly interspersed with shorter and more depressed silvery ones. Under-surface testaceous, with the exception of the abdomen, which is black; very scantily clothed with short pale hairs.

Head with small, closely placed, rugose punctures. Antennae slender,' second joint small and globular, 3 to 8 elongate, the eighth distinctly shorter than the preceding one, club three-jointed, apical joint ovate-acuminate. *Prothorax* elongate, convex, with a shallow subapical transverse impression, posterior margin narrower than the anterior one, sides rounded near the middle; with closely placed punctures, somewhat larger than those on head and more individually distinct. *Scutellum* small and subtriangular. *Elytra* distinctly wider than prothorax, about three times as long as their width at base, sides parallel to about the middle, then slightly dilated, with rows of moderately large, reticulate punctures, beginning at the base and ceasing abruptly at the post-median white fascia, apical portion with very small, almost obsolete punctures. *Legs* long and somewhat slender. Length, 4·5-5·5 mm.

Hab.—Queensland: National Park (H. Hacker); New South Wales: Illawarra (W. du Boulay). Type, in author's collection; co-type, I. 15336, in South Australian Museum; and co-types in Queensland Museum.

Apparently a variable species in its colour and markings, for on some the prothorax is much darker, the lateral margins and base being almost black; two specimens have the anterior part of the elytra entirely pale, with the four white maculae more or less distinct; the humeral angles are either black or testaceous, and the black portions of the anterior part of elytra are sometimes at the margins joined to the black posterior part, and the latter, on account of the faint sculpture, is more nitid than the remainder of the elytral surface

Eleale aenea, n.sp.

Whole of upper-surface coppery, nitid, three apical joints of antennae dull black, labrum with greenish reflections. Clothed with long, black, erect hairs, more numerous on sides and legs, where they are interspersed with white ones, scutellum very scantily clothed with white pubescence. Under-surface blue with greenish reflections, intermediate and posterior coxae violet, clothed with long, shaggy, white hairs, thicker at the sides than elsewhere.

Head well produced in front, with a deep almost circular depression between the eyes, and a more elongate one at the base of each antenna; with close, fine punctures, individually distinct on top and confluent towards forepart. Antennae reaching to the base of prothorax, club five-jointed, joints 9 to 11 compressed, the apical one on the inside with a large, but not deep, emargination, the outside rounded and with the apex acute. *Prothorax* slightly narrower than the head (including the eyes), longer than wide, subapical transverse impression almost obsolete, subbasal one more distinct, sides near the middle evenly rounded; disk flat, with a shallow depression in the middle immediately in front of the base, and one on each side near the middle; near apex with fine, more or less distinct punctures, elsewhere transversely wrinkled. *Scutellum* almost circular and minutely punctured. *Elytra* at base wider than prothorax and about thrice as long, sides straight and parallel nearly to apex and then evenly rounded, humeral angles slightly salient, and behind scutellum with a large, round, and comparatively deep depression: with close, moderately large, deep, reticulate punctures, here and there. transversely confluent, smaller at base and apex, but nevertheless quite distinct. *Legs* somewhat slender, posterior femora not reaching apex of elytra. Length, 8 mm.

Hab.—South Australia: Myponga (R. F. Kemp and A. H. Elston). Type, in author's collection; co-type, I. 15248, in South Australian Museum.

Distinguished from *E. aspera*, Newm., by having the sides of the prothorax dilated near the middle, the transverse wrinkles on same coarser, and the punctures on elytra less crowded and more reticulate. Very near *E. reichei*, Spin., but with the antennae more slender, transverse wrinkles on prothorax somewhat finer, and punctures on elytra much smaller and more crowded. In scultpure very similar to *E. viridis*, Guerin, but distinguished from it by its colour, the club of the antennae more distinctly five-jointed, and the transverse wrinkles on prothorax finer.

ELEALE SIMPLEX, Newm.

Specimens from Western Australia differ from the typical form in being larger, more greenish in colour, somewhat less nitid, and in having the antennae dark with the first three or four joints more or less testaceous; on one, an intermediate form, joints 1 to 4 are testaceous, 5 to 8 are dark, here and there paler, and the three apical joints are a sordid testaceous. *Eleale intricata*, Klug, I believe to be only a variety of this species.

Hab.—South Australia, Victoria, Tasmania, Western Australia.

ELEALE PULCHRA, Newm.

Two specimens from Cottesloe, Western Australia, have the whole of the antennae dull black, with only joints 2 and 3 slightly tinged with red; on one the prothorax has a distinct, interrupted, longitudinal median carina, on the other it is much less distinct. This is, apparently, the form Spinola named *E. bimaculata.*

LEMIDIA ALTERNATA, Lea.

Four specimens from Queensland differ from the typical form by the size and shape of the elytral markings. The red basal band is narrow, the submedian black band very wide, the postmedian red one about half the width of the preceding dark one, and the apical black portion about two-thirds the width of the preceding red part. On all of the four specimens the submedian black band is by far the widest. The whole of the legs are pale, except the posterior tarsi, which are more or less infuscated.

ALLELIDEA BREVIPENNIS, Pascoe.

A specimen taken near Ballarat, Victoria (near type locality), differs from the author's description by having all the tarsi blackish. Pascoe in his Latin description says, "tibiis flavis," and in his English delineation says, "tarsi yellow." This may, perhaps, be an error, "tibiae yellow" being meant, but only a reference to the type, which is in the British Museum, will definitely reveal this. The specimen before me has all the tibiae flavous, and the tarsi blackish.

CURCULIONIDAE.

MANDALOTUS LUTOSUS, Lea.

Four specimens of the above species were taken by R. F. Kemp and myself from moss on the summit of Mount Lofty, South Australia. The male differs from the author's description in having the carina on rostrum distinct, the granules on the prothorax transversely arranged, the under-surface of body diluted with red, particularly the last two segments of the abdomen, the coxae and parts of the under-surface of legs red.

RESEARCHES ON THE INSECT METAMORPHOSIS.

PART I.—ON THE STRUCTURE AND POST-EMBRYONIC DEVELOPMENT OF A CHALCID WASP, *NASONIA.*

PART II.—ON THE PHYSIOLOGY AND INTERPRETATION OF THE INSECT METAMORPHOSIS.

By O. W. Tiegs, M.Sc.,
Zoology Department, University of Adelaide.

[Read October 19, 1922.]

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INTRODUCTION.

The insect transformation presents one of the most interesting of the many phenomena of living things about us. To the popular imagination it is a manifestation of the supernatural. To the biologist it offers unrivalled material for the study of several fundamental tissue reactions: extensive tissue degenerations followed by correspondingly great tissue regenerations; delayed cell differentiation and cell regeneration, and sometimes even, it seems, cellular dedifferentiation; while the cases of phagocytosis at times met with are extraordinary. Nevertheless, its study has been very neglected.

Numbers of the great early anatomists—Malpighi, Swammerdam, Lyonet, Dürckheim—turned their attention to the structure of insects, and though they were able to show that the larvae of insects had already the same general anatomy as had the adult insects, yet the difficulties of the dissection of the soft semi-fluid contents of the pupal shell proved so great, that the process of transformation was not elucidated.

Réaumur, it is true, had been able to show that the limbs of the adult insect were to be found invaginated beneath the surface of the body of the nymph. Newport (1832) had observed the concentration of the ganglia of the ventral nerve cord as it changed from the larval to the imaginal condition, but beyond these facts nothing was known; and Oken, who wrote his voluminous "Allgemeine Naturgeschichte" at about this time (1836), summarized his knowledge of the process thus (vol. 5, p. 714):—"At the last moult the insects become covered by a horny shell, which is devoid of feet and oral appendages. Consequently in this stage they lie quiet for several weeks, often throughout the whole winter, without feeding or moving, and in this condition are spoken of as pupae or nymphs. Under this shell is gradually formed the perfect insect, the fly with its three body parts, with its new feeding organs, feet and wings; finally the skin splits dorsally, the insect creeps out, waits a few minutes till it has hardened, and then crawls or flies away, to seek other food or to reproduce. This gradual step-like development is spoken of as a transformation or metamorphosis."

It was not till the publication in 1864 of Weismann's great memoir on the metamorphosis of the blow-fly that any light was thrown on the process. Weismann, without any modern technique available to him, and using only the old method of hand dissections, studied the process with remarkable accuracy. His observations were made more on broad, general, anatomical lines. He was able to show that the larval tissues underwent a process of disintegration—'histolysis'' he called it—into rounded bodies, which he called Körnchenkugeln, and that the imago in turn was formed from small areas of cells, which Swammerdam had already discovered, though he had not recognized their significance; to these he gave the name ''imaginal discs.'' He was able to demonstrate the sexual organs in a young condition in the larva, and to show that the insect metamorphosis was entirely different from the alternation of generations that occurred in some groups of animals and plants. He demonstrated the occurrence of metamorphosis in most of the organs of the body, including the heart and nervous system, which other investigators with more elaborate technique at their disposal have since questioned; and though his observations were necessarily incomplete, and did not extend largely to cell changes, yet his conclusions were, in the main, correct.

Since Weismann's memoir the blow-fly *(Calliphora)* has been used by a number of investigators for the study of metamorphosis, so that our knowledge of the process in this insect, though still very incomplete, is much fuller than that of any other. In 1876 the Russian Ganin wrote upon it, and described the imaginal ''nests'' within the intestine. In 1884 Van Rees, and in the following year, quite independently, Kowalevsky, guided by Metchnikoff's recent discovery of the phagocytic action of leucocytes, showed that the larval tissues were destroyed by the interference of these colourless corpuscles of the blood. A special interpretation was therefore placed on Weismann's histolysis, and the ''Körnchenkugeln'' proved to be nothing but gorged phagocytes, a fact the truth of which Metchnikoff had himself already perceived from the drawings given by Ganin.

Since that time a number of other observers have added details to the knowledge accumulated by the earlier workers:—Van Rees studied it in 1888; Lowne published a few observations (mostly incorrect) in 1890-1895; Vaney wrote about it in 1902; while Pérez published his very detailed work in 1910.

In 1899, and later in 1901, Berlese published his observations, and seriously questioned the important *rôle* which the leucocytes were believed to play in the removal of the larval tissues. From the earlier writings it seemed to follow that the leucocytes attack the living tissues, so that metamorphosis is, in part, brought about by more than usually highly-endowed leucocytes. Berlese denied this conception entirely. As he appears to have been misunderstood by others, it is best to quote his own words (1901):—''Phagocytosis never occurs, and amoebocytes only become active when the muscle has disintegrated through internal causes." By phagocytosis he evidently means the phagocytosis of *living* tissues; and his "amoebocytes" appear to be a congregation of various kinds of embryonic cells and leucocytes, though he does not specially mention these. Pérez (1910), on the other hand, has taken precisely the opposite view, and regards the leucocytes as playing the main part in the destruction of tissues. "I think I have proved satisfactorily that the disintegration of the muscle is due to phagocytes, and that there is no spontaneous fragmentation of this organ into sacrolytes, as Berlese thought." I may say at once, that the study of the metamorphosis of *Nasonia* has led me to conclude that while neither statement is quite correct neither is wholly wrong; phagocytes play a large part in the removal of larval tissues, but such tissues are always dead.

Besides the observations of these workers, others have been made on portions of the metamorphosis of other insects, but nothing so extensive as those made on the blow-fly exists. In 1875-1878 Künckel d'Herculais published his studies on the structure and transformation of the syrphid fly *Volucella;* Deegener in more recent years has studied the transformation of the intestine in a number of insects; and Verson (1898) examined it in the silkworm. Pérez (1902) examined portions of the metamorphosis of the ant *Formica rufa;* Bauer studied the transformation of the brain in several insects; and in 1912 Günther investigated the development of the eye in *Dytiscus*. In 1910 Poyarkoff published his very interesting observations on the metamorphosis of a beetle, *Galeruca;* he showed that, while some organs underwent the usual type of phagocytic histolysis, others (the integument and part of the intestine) passed through a remarkable process of cellular rejuvenation.

It may be said then, that while we possess a considerable knowledge of the main features of insect metamorphosis, on some of the fundamental facts much difference of opinion prevails. Why do the larval tissues disappear? Do the phagocytes kill them, or do they merely remove them after they have died? If the latter, then how is their death brought about? If in one insect phagocytic histolysis occurs, and in another merely cellular rejuvenation, how are we to correlate the processes? It is these questions that I shall attempt to answer in the present paper. The histological changes undergone by some of the larval organs, moreover, have never been examined—heart, peripheral nerves, ventral nerve cord, and others; whilst the greatest differences of opinion prevail about the details of other organs such as the muscles and intestine.

An equally interesting question is the relation in which the insects which show a metamorphosis stand to those in which it is absent; this question has been discussed by Lubbock (1874), and more recently by Deegener (1909). Lubbock's conclusion, that the metamorphosis was made necessary by the larvae developing different feeding habits and consequently different mouth-parts from those of the adult insects, is not very satisfactory. While it is true that the transition from one to the other would have to be slow and would have to take place during a resting stage, it fails to account for the metamorphosis of structures of almost negligible importance, such, for example, as the fine somatopleural membrane beneath the integument. It fails also to explain the metamorphosis of the feeding organs in insects in which the larvae and adults have the same feeding habits, such, for example, as many of the carnivorous and leaf-eating beetles. Moreover, the real thing to show is why the larval form should ever have been evolved, necessitating the parallel evolution of a metamorphosis, when some insects, very successful in the struggle for existence, have got on so well without it. The conclusion of Deegener, that the larval form is a stage gradually inserted between the early embryo state and the adult, is undoubtedly quite correct, and seems to be usually accepted to-day. Nevertheless he throws no light on the reason why such a form should ever have been evolved, nor does he explain why it later transforms itself into the mature insect.

It was to answer these several questions that the present work was undertaken. The insect which I have employed is a small chalcid wasp, *Nasonia brevicornis*, very common in Australia and America as a parasite on exposed pupae of muscid flies. According to Mr. A. A. Girault it is identical with *Nasonia abnormis*, Boheman, from Europe, and is evidently of world-wide distribution. As the work proceeded I found myself at a disadvantage in that very little was known about the internal anatomy of chalcid wasps, while the study of the anatomy of the larvae had also been greatly neglected, and more than one very serious misinterpretation have been accepted as fact. I have therefore resolved to extend the scope of the paper. In the first portion the various organs of the larva and adult are described and a fairly detailed account of them is given as they transform from the larval to the adult conditions. In the second part I shall attempt to explain the physiological basis of the metamorphosis, and to discuss the factors which have underlain the evolution of the process.

The earlier parts of this investigation were carried out in the Laboratory of the Biology Department, University of

Queensland, and to Professor T. Harvey Johnston I wish to express my gratefulness for permitting me to perform the work there To him, and to Mr. Henry Tryon, Queensland Government Entomologist, I desire to express my obligation for the loan of indispensable literature, so difficult to procure in Australia. I am also much indebted to the trustees and director of the Australian Museum, Sydney, for the permission granted me to examine important publications under their care; and to Mr. W. Rainbow, Museum Librarian, for the facilities which he placed at my disposal. Finally, I wish to express my sincere thanks to Professor T. Brailsford Robertson, of the University of Adelaide, for the many suggestions and kindly criticisms he has offered me since I have known him.

TECHNIQUE.

The methods employed here have been fairly simple. For the examination of the grosser anatomical processes whole mounts stained or unstained, or partial dissections, so far as these could be made, have been used. For all the finer histological details I have employed sections stained by the Heidenhain iron haematoxylin method. Eosin or acid fuchsin has been frequently used as a counter-stain. Fixation was always made with Bouin's "picro-formol" mixture. As these methods gave very satisfactory results in the majority of cases nothing more elaborate was attempted.

PART I.

On the Structure and Post-Embryonic Development of a Chalcid Wasp, *Nasonia.*

A.—The External Features.

The eggs of *Nasonia*, deposited by the female, beneath the hard shell of the fly pupa, on to the surface of the delicate developing nymph, hatch after a period varying from thirty to seventy hours, into small white maggots, about ·3 mm. in length. These are the larvae in the first instar.

The larva (fig. 1) is composed of fifteen segments, of which the last two can easily be "telescoped" into the one preceding them. The last segment is difficult to detect in living material. If, however, the larva is placed in a clearing solution, which causes considerable shrinking in the cuticle, then the segment is unmistakable.

Of these segments the first *two* eventually produce the head of the adult wasp: the next three develop the thorax, while the remaining ten give rise to the abdomen of the insect.

The first segment bears the mouth on its ventral side; the last, the anus; but the larva, though it feeds rapidly, is quite incapable of defaecating. The first two segments bear ventrally a large, powerful, chitinous "rack," the tentorium, which acts as a support for many of the muscles in the anterior region of the animal. The tentorium consists of three chitinous bars—really thickenings of the larval cuticle—two lateral ones, bent outwards, and an anterior connecting bar; while, behind, the structure is supported by a very powerful chitinous bar which is formed in the embryo as a secretion from a pair of epithelial ingrowths from the walls of the second segment

The anterior three bars are shed at each moult, and re-formed on the new cuticle; they do not reappear in the pupa.

The mouth is a rather small, transversely elongated, oval slit, and is armed on either side by a pair of minute, sharply-pointed triangular mandibles, capable of quite active movement. The head is provided in front with a pair of very minute processes, evidently having some sensory function; their nature will be referred to more fully below.

No other appendages are present.

Four pairs of spiracles occur; one on the third segment, the next on the fifth, the third on the sixth, and the last on the seventh.

The larva feeds rapidly and shows a great increase in bulk, an appearance which is accentuated by the inability of the larva to void the intestinal contents. Feeding takes place by the application of the mouth to a hole torn in the integument of the fly nymph by the sharp larval jaws, the food being sucked up into the buccal cavity of the larva. The larva itself does not appear to move from its orginal place of feeding.

After about thirty hours the larva moults; the second instar differs from the first only in its greater size, and in the presence now of a set of nine spiracles.

The larva undergoes several other moults, but it is very difficult to determine their number, as the various instars cannot be recognized by any structural differences. Maud Haviland (1920 and 1921) found four instars in two other chalcid wasps, species in which differences in the various larvae were very obvious.

After feeding for about three days the larva enters upon the *"resting stage"*; food is no longer taken up, and a number of remarkable processes begin within the body of the larva.

Eventually after about a day the larva defaecates, the contents of the intestine being voided as minute rounded greyish or black pellets; as a result the larva changes from a dirty grey to a pure white colour.

During the next twenty hours—*the post-defaecation* *period*—the changes commenced in the resting stage continue; other changes, which have gone on at a very slow rate during larval life, become greatly accentuated. A convenient termination for this somewhat artificially conceived period is the last larval moult, which discloses the pupa (fig. 7).

Moulting is initiated by a dorsal splitting of the larval cuticle. The integument of the pupa is covered with minute papillae, which produce a rough surface; and this the pupa employs in freeing itself from the larval cuticle. The actual ecdysis lasts about an hour, and may best be described as taking place by a slow wriggling of the nymph, the larval sheath being gradually pushed farther back.

The liberated pupa has in many respects the appearance of the adult insect. The general shape and size of the pupa is the same as that of the imago; the antennae, legs, and mouth appendages have attained their full length, but are thick, "fleshy," and ungainly in appearance. In the female the ovipositor is quite prominent, lying along the median ventral surface of the abdomen.

So far, then, as the external features are concerned, the most pronounced transformation takes place not in the pupa, but in the resting stage and post-defaecation stages of the larva. I shall describe first the changes in the external appearance of the developing insect as it lies within the larval sheath, and then follow the structures, so produced, as they continue to develop under the cuticle of the last instar—the so-called "pupal-sheath." This will be followed by an examination of the histological processes which bring about these remarkable external changes; and finally, the internal transformation of the larva will be described. These changes, however, must not be regarded as commencing at, or near, the time of pupa formation; they have, to a certain degree, been going on during larval life; slowly, indeed, and perhaps even spasmodically, but still they *have* been going on. Some time before moulting, however, these changes have become accentuated, and others, which have not yet commenced, are now initiated; but even these are to be regarded only as the result of processes which have gone on in the larva.

The general shape of the "living" portion of the feeding larva is identical with that of the larval cuticle which it has secreted, *i.e.*, it is an elongated ovoid maggot, thick in the middle, and gradually tapering at either end. But some time before defaecation starts the integument beneath the cuticle begins to change its general shape; that of the first two segments begins to round itself off, and, before the larva moults, has transformed itself into the head of the future wasp. A gradual increase or diminution in the size of the following three segments gives the thorax the general shape that it has in the imago; the abdomen shortens considerably, rounds itself off, constricts considerably at both ends, while at the same time portions of its anterior segments move forwards, and fuse with the thorax to form a compound structure, the "alitrunk," so characteristic of the Hymenoptera.

The head and its appendages may be considered first.

The Head and its Appendages.

The head of the adult wasp is developed from the first two segments of the larva; the first segment, to which the name *oral segment* may be applied, develops into the front and lower portions of the head, and gives rise also to the antennae and labrum. The second segment may be called the *post-oral segment;* from it develop the upper and occipital regions of the head, including the ocelli and great eyes, while below it produces the maxillae and labium and also the mandibles.

The fact that the first two segments of the larva are concerned in the formation of the head can readily be verified by following the spiracle of the third segment through the metamorphosis, the spiracle remaining as that of the first thoracic segment. Already in the late feeding period of the larva, the imaginal discs of the head appendages have become clearly visible. From the upper portion of the first head segment the antennae grow out as short thick processes, which, on account of the pressure of the larval cuticle above them, are forced to grow downwards (figs. 3, 12). Each antenna has, towards its distal end, a short blunt papilla, which fits into the sensory structure on the first segment, referred to above.

Around the mouth, the other head appendages soon become prominent; immediately in front of the mouth are a pair of quite distinct outgrowths—the rudiments of the labrum—which structure is, at this stage, distinctly paired (fig. 13). The labrum is generally regarded as a simple, unpaired downgrowth from the upper edge of the mouth, but in *Nasonia* its paired condition is quite clear; Patten has also figured the labrum as a paired structure in *Acilius.* (See Korschelt and Heider, part iii., p. 326, fig. 160).

The other mouth appendages are developed from the second (post-oral) segment; their actual interpretation is, at first sight, very confusing, for though they are developed from the post-oral segment, some of them take up a position actually somewhat in front of the mouth, which is situated well within the first segment. The apparent paradox finds its explanation in two facts: firstly, the small mandibles of the larva, which are merely a chitinous secretion from a part of the mass of cells which will later develop the mandibles of the adult, are produced from a short mandibular imaginal disc, which grows forwards from the second segment and terminates close beside the mouth; secondly, in the late larval stages there is a considerable shifting forwards of the lower surface of the head, the anterior portion of the second segment being pushed into the cuticular sheath of the first. (I may draw attention here to a fact from which an important deduction can be made later, *viz.*, that the antennae and mandibles of the larva, though so absolutely distinct from those of the adult, are yet developed in close connection with the same group of cells—the antennal and mandibular imaginal discs—as produce the corresponding structures in the adult wasp.)

Of the "post-oral" appendages four pairs may be recognized. The most anterior is a pair of short outgrowths, which I shall call here the second antennae (fig. 13). Their homology will be considered below. Immediately behind these arise a pair of long outgrowths, which end close to the larval mandibles—they are the mandibular rudiments; close behind these, and nearer the mid-line, is a pair of short stout maxillary rudiments; and behind these, and still nearer the middle, are the rudiments of second maxillae, quite distinctly paired at this stage (fig. 13).

Of these appendages the mandibles are the largest, and I have seen larvae, slightly before defaecation, *in which each is provided with a palp*, which, at this stage, is even longer than the mandible itself (fig. 3). I have also observed larvae, in the same stage of development, in which no mandibular palps were visible. In order to be certain that I was not confusing the mandibles with the first maxillae, I examined the mouth appendages of defaecating larvae, cut in serial sections; under which conditions no error could be made in determining the various mouth appendages, and the mandibular palp could be clearly seen (fig. 48). A mandibular palp has not, so far as I am aware, been found hitherto in insects. Of special interest, however, is the fact that it does not appear to be present in all larvae, its occurrence being perhaps a frequent "abnormality."

The first maxillae are rather short thick outgrowths at this stage, and each has a short palp on its outer side. The second maxillae are small, and each has a very distinct palp, which twists around the maxilla from below, and embraces it distally. At the sides of the second segment are the great compound eyes, already differentiating in the late larval period; and in the middle lie the great cerebral ganglia (fig. 3).

The post-defaecation period is marked by a continued growth of these imaginal rudiments, the completion of the process being marked by the last larval moult.

The head integument bulges outwards, and the bisegmental condition disappears (fig. 12). The head grows, especially in height, while above and below the posterior head integument grows inwards to form the nearly vertically sloping occiput. As a result of these changes, and probably also on account of the pressure exerted upon it by the overlying larval cuticle, the head adopts the curious retracted attitude so characteristic of the insect. The second segment may also be observed, at the end of larval life to be partly invaginated into the third. In *Calliphora* this condition is much more pronounced.

The antennae have meanwhile been growing greatly in size. Originally forward outgrowths from the upper region of the first segment, the pressure of the larval cuticle soon forces them to turn back upon themselves and downwards; in the post-defaecation period they grow greatly in length and thickness, and at the time of pupation, are in the form of two thick appendages, lying ventrally and extending two-thirds the distance down the thorax (fig. 7).

The mouth parts meanwhile continue to grow in size, the turning downwards of the head, as already described, forcing these into the position in which we see them in the imago. Shortly before the larva undergoes its last moult they cease to grow, and develop a cuticle on their surface. They are now large thick ungainly structures (fig. 14), in no way resembling the neat, specialized mouth parts of the imago. The labium is a triangular, irregular flap overhanging the mouth; the mandibles are a pair of irregular, "shapeless" masses, each bearing its palp, which has now, however, greatly degenerated and is little more than a tubercle on the mandible. The maxillae are nearly as large as the mandibles and project forwards; the palps exceed the maxillae in size and are extremely prominent. The labium is quite large and from its posterior part project the palps. The second antennae have disappeared.

The remainder of the development of the mouth appendages, during the pupal period, consists of a very pronounced shrinking of the structures within the cuticle which they have secreted, as a result of which they gradually assume their adult shape (fig. 14).

This process commences a few hours after pupation, and within twenty-four hours is practically complete; segmentation of the appendages has become very marked, and bristles are developing on them. The proximal portion of the labium (fused mentum and submentum) is almost square in shape, and from it spring the medium-sized labial palps. The distal portion of the labium (fused endopodites) is slightly wider than the proximal portion (fig. 14), and its surface is developing a very delicate pubescence. The labial palps are rather club-shaped, with a distinct indication of three segments; bristles are already clearly visible on them. The first maxillae have shrunk to rather short, stylet-like structures (fig. 14), and have developed bristles; while the huge maxillary palps of the early pupa have shrunk to a pair of graceful, four-jointed appendages, on which bristles have also begun to develop.

The shrinking of the mandibles has been less pronounced; each has assumed the shape of a powerful, slightly curved jaw, armed distally with three (occasionally with four) short blunt teeth; the mandibular palp has entirely disappeared and its position is indicated, now, only by the chitinous tubercle of the pupal sheath.

The labrum does not undergo any marked changes, except a diminution in size.

As a result of these processes the mouth appendages, in the shapes in which we see them in the adult, have been produced; chitinisation of this cellular mould, which soon ensues, results in the more marked segmentation and the hard consistency of the mouth parts, such as we see them in the mature wasp.

The antennae, meanwhile, have been undergoing changes parallel to these; at the time of pupation, as we saw, the antennae were in the form of two thick, slightly segmented appendages lying laterally along the ventral side of the thorax.

In the early pupal periods the segmentation becomes more distinct, and at the same time shrinking takes place; as a result of these processes, the antennae adopt their adult appearance after about thirty-six hours; bristles, which are first seen some eight hours after pupation, are well marked at this stage; rapid chitinisation of the surface of the antennae ensues, resulting eventually in the production of the fully developed appendages.

The antennae of the male and female differ slightly; in both sexes there is a long proximal joint, followed by a joint about one-third the length of the first; then come two very small joints, followed by nine larger ones, all of about the same size. In the female the last three joints are arranged so as to form a very distinct club (fig. 11); in the male no such modification can be seen.

The chief point of interest in the development of the mouth appendages is the occurrence of a mandibular palp, probably as an abnormality (since some individuals do not appear to show it); the occurrence of this palp definitely proves the homology of the mandible with a metameric appendage.

The curious nature of the labium is worthy of special attention. Its anterior surface, formed as a chitinisation of the protoplasmic "pubescence" already described, is developed into a strong rasping-organ. Though present in both sexes the "rasp" is more strongly developed in the female. The strength and efficiency of the labium is further increased by a pair of hard, outwardly diverging chitinous bars lying within its distal segment.

Also to be especially noted is the fact that the head appendages first grow in size, and not till the mature size has been reached, and even exceeded, does differentiation take place. This same fact will be seen also in the development of the legs and ovipositor and other appendages; it seems, indeed, to be true of the body surface in general (fig. 8): first the body becomes moulded, then it begins to undergo differentiation producing the various joints, spines, bristles, sculpturings, etc., that adorn the insect's body—first growth and arrangement, then differentiation. This fact can be demonstrated especially clearly in the compound eyes (see these). . The post-defaecation and resting periods are the time in which the optic cells adopt their *arrangement;* in the pupa they differentiate.

Looked at in this light it is possible to regard the pupa not merely as an artificially conceived, but as an embryologically quite distinct phase. Growth occurs in the resting and post-defaecation periods; the pupal period is the period of differentiation. It should be clearly understood that these remarks refer merely to the external characters (integument).

Meanwhile the great eyes and the ocelli have been developing. These structures are merely modifications of the integument; already in the resting stage the great eyes are clearly recognizable; they grow over a large part of the sides of the second segment. In the defaecating larva facets are already clearly indicated; these become more distinct as development continues. At the end of the larval life the eyes are very large, and have assumed their typical bulged appearance. After thirty-six to forty hours the eyes gradually change from a creamy to a pale-reddish colour, which becomes bright red a day later.

The ocelli have meantime been developing at the vertex of the head, and are seen in the newly formed pupa as three prominent rounded tubercles arranged in a triangle.

After about three and a half days the head gradually blackens, and this blackening soon spreads backwards over the whole body; as a result the head is now seen to be marked with the sculpturings characteristic of the species.

The Constitution of the Head.

Having now described the development of the head, we may apply the observations to an attempt to determine the metameric constitution of the insect head.

Regardless of the actual position which the head appendages have taken up, secondarily, we may enumerate and classify them as follows:—

(a) Pre-oral appendages—antennae, labrum (on first head segment).

(b) Post-oral appendages—"second antennae," mandibles, first maxillae, labium (on second segment).

The oral segment gives rise to the face; the post-oral segment develops into the occiput, the vertex, and probably into the frontal region; from it develop the ocelli and the compound eyes.

This bisegmental condition seems to be very common among chalcid wasp larvae. Berlese, for example, in his figure of *Tapinoma erraticum*, actually shows the cerebral ganglia lodged in the second segment, while the third possesses the first (thoracic) spiracle; the same thing is seen in *Diachasma*, and in the encyrtid wasp *Australencyrtus*, and is probably very common, if not universal, among these parasitic hymenoptera. The presence of two head segments is especially useful in helping us to determine the homology of the insect head.

The presence of three biramous appendages can be interpreted only in one way, *viz.*, that three body segments, of the primitive annulate-like ancestor of the arthropods, gradually moved further and further forward, till eventually they became incorporated into the head. This is, however, it seems, the usually accepted view; the occurrence of a mandibular palp as an abnormality makes the homology more certain than ever. What the exact limits of these suppressed metameres on the post-oral segment really are, it is not possible to say.

The oral segment is provided with two pairs of appendages, which have never been observed in a biramous condition —the antennae and the labrum. The position of the antennae so far forwards, with no appendage in front of them, confirms Korschelt and Heider's view that the antenna of the insect is homologous with the crustacean antennule; the small larval sensory structures already referred to must, since they are formed from the "antenna," be likewise homologous with the Crustacean antennule, or at least with a small portion of the antennule It should be noted, also, that the presence of the antenna (antennule) on the oral segment does not prevent its arising in embryos *behind* the mouth, a fact which Weismann first discovered in Diptera, and which has been confirmed by Heider for *Hydrophilus*, by Patten for *Acilius*, by Nusbaum for *Meloe*, and by others

When, now, we look in the *Nasonia* larva for the representative of the true antenna of the primitive insect it seems that the structure which I have spoken of as the "second antenna" must be looked upon as such. It arises from the post-oral segment, but actually takes up a pre-oral position, and is quite a transient structure. This same post-oral segment also gives rise to the eyes and ocelli

It seems then that we must regard the insect head as composed of at least five segments; the first bears the mouth, the labrum, and the "antennae"; the second bears the vestigeal true (second) antennae, the ocelli, and eyes; the third is represented only by the mandibles; the fourth by the maxillae; and the fifth by the labium.

It is unlikely that the three segments, with biramous appendages, should be anything but the first *true* metameres of an annulate worm; the oral segment would then represent the procephalic (prestomial) segment of the annulate, and the post-oral (with the exception of the three biramous appendages) would be the descendant of the cephalic (peristomial) segment. The presence of the mouth on the second segment of Polychaetes cannot be taken as contradicting this view, since in the Oligochaetes it is on the first segment. The view above expressed receives very strong support from the fact that the post-oral segment of *Nasonia* and the peristomial segment of the annulate both lodge the cerebral ganglia

The view above expressed, then, would regard the insect head as built up of five annulate segments as follows:—

Name and No. of Segment.	Represented in *Nasonia* larva by—	Represented in Imago by—
1. Procephalic segment	Oral segment	Face, antennae, labrum, mouth
2. Cephalic segment	Post-oral segment	Apex of head, occiput, brain, compound eyes, ocelli
3. First body metamere		Mandibles
4. Second body metamere		Maxillae
5. Third body metamere		Labium

The extreme view of the constitution of the insect head was taken by Savigny (1816) who regarded it as consisting of seven segments, corresponding to the antennae, labrum, ocelli, great eyes, mandibles, maxillae, and labium; that the uniramous antennae and labrum indicate two distinct segments, is very improbable; that the eyes and ocelli indicate such segments is impossible. Huxley regarded the head as constituted, most probably, of six segments. A much better conception is that of Lowne (1890), who regards the insect head as composed of four segments; his large head capsule (paracephala) lodges the brain, eyes, and antennae and bears also two bulbous prominences in front—the (upper) posterior cephalocoele, which bears the ocelli, and the (lower) anterior cephalocoele. The fact that the posterior cephalocoele bears the ocelli shows it to be homologous with the upper part of the second segment of *Nasonia;* the paracephala of Lowne are homologous with the remainder of the second (post-oral) segment in *Nasonia*, excluding, of course, the appendages which Lowne speaks of collectively as the "metacephalon." It is the anterior cephalocoele and the neighbouring parts of the paracephala which are specially interesting; this region bears the antennae, and gives rise in various insects to the epistome, the labrum, and the rostrum, and probably the mouth; and there can be no doubt that it is homologous with the oral segment of *Nasonia*. Lowne working with a number of insects never found it as a distinct segment, the structure having evidently become merged into the paracephala. An examination of the *Nasonia* larva, however, leaves no doubt as to its being segmentally distinct.

The posterior cephalocoele is the *Voderkopf* of Korschelt and Heider. According to Lowne it persists in dragon-flies as a bladder-like swelling which lodges the ocelli; its persistence in Coleoptera seems to be proved by Lowne's discovery of ocelli as an abnormality in *Cicindela;* in the *Muscidae* a great part of the posterior cephalocoele is withdrawn into the rest of the head, as the cerebral vesicles, which are evaginated during metamorphosis.

The only difference, then, between the view of Lowne, and that which I have expressed above, is in the bisegmental nature of the "paracephalon." In most insects its existence is only a possibility; in *Nasonia* it is a certainty. In figs. 42 and 43 of his work on the blow-fly, moreover, Lowne actually figures embryos of *Calliphora*, in which the head consists of five segments, and actually appears to be in a condition similar to that of the free larva of *Nasonia*. His figures are taken from Weismann's great work.

The (true) Thorax and its Appendages.

The true thorax of the imago is represented by the third, fourth, and fifth larval segments, which are all fairly equal to one another in size. Running vertically down each segment, on either side, and close behind the spiracle, is a narrow streak of integument differing from that which covers the remainder of the segment These six narrow streaks constitute the imaginal discs of the thorax (fig. 2).

They are clearly visible through the cuticle of the advanced larva, and connected with each are the imaginal discs of the thoracic appendages (figs. 2, 5, 6); the first pair bear only the first legs; from the second (mesothoracic) segment develop the first wings above, and the second legs below; the third (metathoracic) disc bears the second wing disc above, and the rudiments of the third legs below.

The wing discs are rather elongated and can be seen to be enveloped in a distinct sac. The leg discs are much shorter than those of the wings; and the sacs in which they are carried are very distinct, each bearing a small opening on to the surface of the integument, below the larval cuticle. Neither in the wing, nor in the legs, could I detect any indication of a biramous structure.

During the resting stage of the larva the imaginal discs begin to grow rapidly; the integumentary discs spread out in all directions, the first two, especially the second, rapidly; the last very slowly. The discs of the appendages soon grow out of their sacs; already in the larva at the time it defaecates the legs have protruded so far that they begin to bend upon themselves beneath the larval cuticle, and we see the earliest indication of segmentation. The wing discs, on the other hand, grow downwards as two large sacs, and do not bend (fig. 3).

About ten hours after defaecation the discs have, to a large extent, assumed their imaginal shape and size; not till about the time of pupation, however, as will be seen later when we examine the histological structure of the developing discs, is the process of encroaching quite complete. The first thoracic disc is now seen to have projected forwards to form a hood over the upper part of the head; the second disc has far outstripped the other two, and, growing right under the cuticle of the first thoracic segment of the larva soon assumes its imaginal dimensions; from it about three-quarters of the thorax develops; the metathoracic disc scarcely lengthens at all, and persists as a small ring behind the great mesothoracic segment.

The legs and wings have meantime been extending, and already in the larva a few hours after if has defaecated the process of segmentation of the legs has proceeded far. In the larva ten hours after defaecation a coxa is distinctly visible behind the femur; the region where the leg showed its original bending marks the beginning of the tibia; the tarsus is also clearly visible; on the third tarsus at least four segments have been produced, on the other tarsi joints are just forming. No trochanter is visible yet.

The wings have meanwhile grown in size. The first wings are now in the form of two great hollow sac-like pockets, on either side of the mesothoracic segments; the hind wings are much smaller.

In the larva a few hours later the legs have grown so long that they are found beneath the thorax, and their distal ends begin to grow backwards; the wings continue to grow in length, and likewise become forced backwards.

The proximal wide "mouth" of the wings contracts more and more, and the great sac-like structures transform, in the late larva, into others having the shape more nearly of the wings of the adult. Rapid growth of the legs continues, so that just before the end of larval life the first leg has grown backwards nearly to the end of the thorax; the second about one-third the distance down the abdomen; the third about one-quarter the length of the abdomen from the end. The wings also, especially the first wings, have become very large and have enveloped the sides of the thorax.

All the segments of the legs, except the trochanters, are cleary seen; but the legs themselves are thick fleshy structures, resembling only in a general way the legs of the adult (fig. 16). The same thing has been described above in the mouth-appendages.

At an early stage in their formation as distinct appendages, *i.e.*, in the resting larval period, tracheoles began to extend into the wings and legs. Each leg is provided with a single long tracheole occasionally branching into two parts distally. The wings, on the other hand, are well provided with tracheoles. Their actual structure and their history within the wings will be described later; it will suffice to refer here merely to their general disposition within the wings.

Running along the lower (anterior) border of the wing are a pair of tracheoles (figs. 44, 65), one of which is bifurcated distally. They appear to communicate in the proximal portion of the wings. Passing down the middle of the wing are a number of tracheoles, which appear also to be branches of a single large tracheole at the base of the wings, this large tracheole giving off a pair of smaller vessels, each of which bifurcates in about the middle of the wing. One of these small vessels passes to the end of the wing and there turns upon itself and runs forwards again. These tracheoles, as well as those of the legs, are all markedly twisted and irregular.

Meanwhile the thoracic segments have been undergoing further development. The second segment becomes somewhat convex; the first segment grows downwards, and instead of overlying the rear of the head, now comes to assume its proper position as a shield over the neck and front of the thorax. A mechanical explanation of this will be given later (see Muscular System).

The metathoracic segment retains its insignificant size.

Having arrived at their maximum size, the thoracic segments and their appendages form a cuticle. This process, which is coincident with cuticle formation over the rest of the body, is quickly followed by the pupal moult.

The thorax, which has now attained its general adult shape, begins to undergo changes parallel to those that go on in the head, *i.e.*, ridges, grooves, tubercles, bosses or depressions, etc , are developed on its surface in the positions in which we see them in the imago. This process takes place on the first day of pupal life, and is soon followed by chitinisation. Already in the thirty-six hour pupa this has proceeded considerably, and the only changes which take place during the remainder of the pupal life consist in a thickening of this chitinous coat, accompanied by a general blackening, following close on the blackening of the head.

The legs, meanwhile, undergo continued "differentiation"; they shrink greatly within their cuticle, and the segments become more clearly marked (fig. 16). Already at about six hours after pupation the shrinking has permitted the growth of (protoplasmic) bristles on the surface of the legs; soft claws and spines are soon seen, and the trochanters are clearly visible some twenty-four hours after pupation. The view of Lowne that they are really part of the femur, and that they do not represent a distinct segment, comparable, for example, to the coxa, or tibia, seems justified by their very late appearance in the pupa, the true segments being clearly visible even in late larval stages. Some twenty-four hours after pupation the legs have practically assumed the external appearance of those of the imago. This is followed by the secretion of chitin, at first slow, later rapid, so that at the end of two and a half days the legs of the pupa are (to external appearances) identical with those of the adult wasp.

The wings, also, have continued to develop during this time. First a considerable shrinking takes place, so that the wing occupies, in the twenty-four hour pupa, an area about three-quarters the size of the wing of the newly formed pupa (fig. 44). Already in the pupa a few hours old, the upper and lower pairs of veins of the fore wing are seen to lie each within a broad clear space, extending from the base of the wing to a distance about one-fifth the length of the wing from the end. In the twenty-four hour pupa these clear areas have become much more distinct. In the hind wings, so far as I could observe, only a single such clear area is formed. The wings meanwhile have assumed, more nearly, their adult shape, showing now a very slender proximal region, and developing, at the same time, each a small basal structure provided with a number of irregular prominences and depressions (fig. 9), which articulate with, or into which fit, other depressions and projections from the sides of the thorax.

The wing now assumes a remarkable appearance; instead of remaining as a smooth fleshy structure, its surface begins to undergo, in the thirty-six hour pupa, a very pronounced folding (fig. 37); at the same time hairs—the fine pubescence of the adult wing—as well as bristles, and the hooks of the hind wings begin to appear on the surface. The folding is soon complete, and the whole structure now begins to chitinise.

The chitin on the hooks of the hind wings becomes fairly thick; elsewhere, however, the chitin remains thin, and closely follows the contours of the wrinkled surface of the pupal wing.

The anterior clear space of the fore wing, and that of the hind wing become brown in colour; they form the nervures of the adult wings; the bifurcated clear areas on the rear half of the first wing do not change colour, and remain as colourless "pseudo-nervures," so characteristic of the wings of many chalcid wasps.

On emerging from the pupa the wings of the wasp soon straighten out. Not till now can we actually estimate the extent to which folding of the wing epithelium has taken place; for so pronounced has been the folding within the limited space afforded by the pupal cuticle covering the wings, that these, on expanding fully, attain, in the course of a few minutes, an area sixteen times that of the pupal wing.

At the rear of the fore wing a slight turning over of the wing chitin forms the only structure on which the great hooks of the hind wing can possibly find a grip.

The actual cellular processes which underlie this remarkable development of the wings will be described later (see page 359).

One point seems to be worthy of special attention here. The fact that the clear spaces (developing nervures) of the pupal wing may at times be quite devoid of tracheoles, while at other times they may lodge two tracheoles, if not more, seems to show that the nervures have no relation whatever to these respiratory tubes, and that the latter have grown into them merely because they represent a path of diminished resistance to growth. It seems to follow, also, that attempts to arrive at any conclusions as to the phylogeny of families and genera (in the chalcid wasps, at any rate) on the basis of pupal wing structure are fallacious, unless special distinctions are drawn between the wing nervures and the tracheoles which they may contain.

The Abdomen and its Appendages.

The abdomen of the wasp is built up from the last ten segments of the larva, and in its general features the development is identical with that of the thorax, *i.e.*, the narrow imaginal discs of each segment grow outwards beneath the cuticle of the larva and assume the general shape of the abdomen of the wasp. The imaginal discs, moreover, are similar in appearance to those of the thorax (fig. 2), being in the form of narrow strips of tissue, running vertically down each segment close behind the spiracle (in those segments which possess one). The imaginal disc of the last segment occupies the whole of its lower lateral regions.

The general shape assumed by the abdomen is ovoidal; but in this the first two segments do not co-operate; on the other hand, a remarkable migration takes place here, and the whole of the first abdominal segment, and the upper half of the second, become merged in with the thoracic segments, to form the middle region of the insect, the hymenopteran "alitrunk," while the lower part of the second abdominal segment forms the petiole, which in the adult wasp connects the "abdomen" with the alitrunk, and articulates with the upper part of the second segment, with which, therefore, it always remains in fairly close intimacy.

It is in the larva about twelve hours after defaecation that this process of migration is first indicated. At this stage a horizontal splitting is seen in the second abdominal segment, and shortly after, the first segment, and the upper half of the second, begin to move forwards, while the lower portion of the second retains its position, and eventually forms the petiole. At the time when the larva moults, these two segments have distinctly left the remainder of the abdomen, and have produced the "alitrunk" (fig. 7). At this time, also, the abdominal discs have completely encircled the body, and the lower portion of the second abdominal disc has so constricted as to give it the form of the petiole; already in the larva fourteen hours after defaecation the petiole is clearly seen. As on the rest of the body, the attainment of adult proportions is rapidly followed by the secretion of a delicate cuticle, after which the larva moults.

The changes which occur during pupal life in the abdomen are quite parallel to those occurring on the remainder of the body. A certain amount of shrinking takes place some twelve hours after pupation, bristles form on various parts of the body; the small sculpturings of the wasp's body are moulded on the soft epithelium of the pupa, and then the whole abdomen undergoes chitinisation. The blackening of the abdomen takes place on the fourth day, soon after that of the head and thorax, *i.e.*, the wasp blackens from before backwards.

The two abdominal segments which have become merged into the alitrunk undergo but slight changes during pupal life. Just as the first thoracic segment grows downwards to form the front wall of the thorax, so the two migrated abdominal segments also grow downwards to form the rear wall of the "alitrunk." The two processes take place at the same time, and are to be explained, I believe, as the result of a pull, exerted upon them by the contraction of the great longitudinal thoracic muscles, which pass horizontally from the one to the other (see below, p. 426). This pulling downwards results in the more distinct separation of the alitrunk from the rest of the abdomen. The chitin in this region becomes extraordinarily thick, and the whole surface undergoes remarkable sculpturing. In the two-day pupa, the upper part of the second abdominal segment is still clearly visible as a small square segment embedded in the one preceding it; it is about equal in size to the petiole, with which it articulates. As chitinisation advances, however, it becomes more and more difficult to detect.

That the alitrunk contains the first abdominal segment is, of course, well known. But that the upper portion of the second segment is also incorporated in the alitrunk does not seem to have been recognized hitherto. Thus Sharp (1895) writes:—"The structure of the posterior part of the alitrunk has given rise to an anatomical discussion that has extended over three-quarters of a century, with the result that it is now clear that the posterior part of what appears to be thorax in Hymenoptera is composed of the abdominal segment. This part has been called 'Latreille's segment,' the 'median segment,' and the 'propodeum.'" . . . "Although the true first segment of the abdomen is detached from its normal position and added to the thorax, yet the term abdomen is conveniently restricted to the part that commences with the true second segment" (part 1, p. 492).

To what extent this bisegmental condition of the propodeum is found in Hymenoptera generally I am unable to say. In *Nasonia* there can be no doubt of it, but to determine its constitution in other groups would necessitate an embryological examination of these, the study of mature material being generally useless.

It remains only to describe the segments of the rest of the abdomen. The third segment is large and conical and overlaps the second, which is rather shorter; the next is very long, and the following two rather shorter. The last four segments are small and together form the posterior quarter of the abdomen (fig. 4).

Chitinisation has taken place so as to produce distinct terga and sterna.

The sterna of the seventh and eighth segments do not meet below, the body being protected here by the sternum of the ninth segment. The tenth segment is partly invaginated into the preceding one and is represented by a terminal plate which bears a long horizontal slit, the anus (figs. 21, 26). Surrounding this plate are other podical plates, but whether these are formed from the last, or from the antepenultimate segment, I am not definitely able to say. The last segment is interesting in that it bears in the female a pair of processes, which grow out some ten hours before putation; in the newly formed pupa they are in the form of short blunt appendages a little longer than broad, quite prominent in ventral view (fig. 21).

In the early pupa the usual contraction takes place, and they remain as short conical papillae at either side of, and just below the anus; each is covered with long bristles, developed early in pupal life. These are the tactile hairs, and the structure serves as a delicate sense-organ for the female in the examination of the surface of the fly-pupa for a suitable spot to pierce with her ovipositor.

The modifications which these structures undergo in the male will be described in connection with the development of the male copulatory organs; histological details will be given in connection with the description of the integument.

In the female, meantime, the ovipositor has been developing. This is represented in the feeding larva in its last instar by three pairs of imaginal discs, situated in the twelfth, thirteenth, and fourteenth segments, and identical in appearance with the anlagen of the legs (fig. 2); there is no evidence of a biramous structure. Some time before defaecation these appendages grow out above the surface; the upper pair grow backwards along the ventral side of the insect as two hollow appendages, lying parallel to each other (fig. 20); the second appendages similarly grow backwards ventral to these, also as two hollow appendages, but more closely applied to each other; the last pair, on the other hand, extend mainly forwards, and serve as a lateral protection for the other four appendages which the former partly enclose. Growth is rapid, and the posterior appendages assume the function more and more of a protecting sheath for the other two pairs. Already in the defaecating larva the second pair are closely adhering; in the larva eighteen hours later the two have almost formed one tube, and by the time the larva moults, there can no longer be any doubt as to the occurrence of a distinct cavity in this structure. This cavity, however, is not formed by a fusion of those of the two appendages; on the other hand, it is the result of an incomplete fusion of the walls of the two appendages, due to the invagination of the inner half of each into its outer half. The anterior pair of appendages meanwhile grow in thickness, and tend to fill the available space enclosed by the last pair.

The first pair of segments meanwhile give off each an anterior offshoot which grows upwards and curves backwards into the abdomen of the wasp (fig. 21); from the end of this outgrowth, a second portion grows downwards and forwards. This process seems to be complete at the time of pupation. Already in the larva, eighteen hours after defaecation, a distinct chitinous cuticle has been formed around the external parts of the ovipositor, and the organ is now prepared for the moult. At the time of pupation, then, the ovipositor has assumed its general adult appearance, but as with all the other appendages, the structures are merely moulds for the adult organs—they have attained their required sizes; they have now to differentiate.

This takes place in the early pupal period. The first pair of appendages shrink, and tend to enclose the second fused appendage, which has also shrunken; the posterior pair of appendages similarly shrink, and remain as somewhat flattened thick sheaths, protecting the others (fig. 22).

The aperture of the female sexual ducts is a wide transverse slit-like structure, and this opens into the cavity enclosed by the first and second appendages. It will be referred to more fully in connection with the female sexual organs. The second appendage becomes serrated distally and projects slightly beyond the tips of the first pair. The whole structure, in the two-day pupa, then undergoes chitinisation, to form the ovipositor of the adult.

This complex organ consists, then, of a protecting sheath (third appendage) which encloses the actual egg-depositing tube. The latter consists of a slender but very stout rod, serrated distally (fig. 22), whose function is to bore through the fly-pupa prior to oviposition, the eggs entering the hole through a tube formed between this rod and the pair of first appendages which partly surround it. The proximal portion of these first appendages has grown in a strong curve, as described above, into the abdomen of the wasp; a second piece growing forwards and downwards from the end of this has also been described above. These structures likewise chitinise and produce an exceedingly efficient system of phragmas. The insect has, as it were, taken full advantage of this, and a great group of muscles has developed, whose function is to move and hold the ovipositor while the latter is functioning. These muscles are shown in fig. 22. One group radiates out from the base of the second appendages, and is inserted on to the first portion of the phragma. Other muscles are inserted into the descending portion of the phragma; others, again, are attached to the base of the ovipositor. A system of smaller phragmas is also developed on the ventral body wall to give firmer attachment to the "origin" of these muscles. The figure, however, will make this elaborate system of muscles clearer than any verbal decription can.

The action of the ovipositor is now obvious; a pull by the muscles of the great phragmas will immediately swing the ovipositor forward out of its sheath (third appendage) into a vertical position, and the prolonged contraction of these and other muscles holds the ovipositor very rigidly for several minutes, during which the upward and downward movement of the abdomen causes the rigidly fixed ovipositor to bore its way through the hard sheath of the unfortunate fly-pupa.

It is worth noting here, that during the development of the abdominal imaginal discs, the eleventh *body* segment (sixth abdominal) grows backwards a considerable distance along the ventral body wall and overlaps more than half the anterior portion of the ovipositor. During oviposition, consequently, when the very flexible abdominal segments are subjected to considerable strain, the ovipositor pushes these overlaps forwards and has, then, the appearance of arising from a pyramidal structure on the ventral side of the body. No such structure is, of course, normally present.

The histological changes which underlie this development will be referred to under "the integument."

The devolpment of the ovipositor of *Locusta* has been described by Dewitz (1875). He describes an anal segment bearing a pair of appendages (cerci) homologous probably with the sensory papillae of *Nasonia*. The ovipositor is developed, according to Dewitz, from the three preceding segments, one of which is formed late in life. The only apparent difference between the structure seen in *Locusta* and that found in *Nasonia* lies in the fact that the two second appendages do not unite (in *Locusta)* to form a boring organ, and that the third appendages do not merely act as a protecting sheath for the ovipositor, but actually enter into its formation.

It is necessary to describe next the formation of the copulatory organs in the male.

So far as I could observe, no rudiments corresponding to those of the female copulatory organs are present in the male larvae, and no special differentiation of external male organs takes place till very late in larval life. This is intimately connected with certain changes in the last four abdominal segments, which become so disposed as to allow of the eversion of the penis.

Shortly after the defaecation period the tenth and ninth imaginal discs of the abdomen have grown so as to assume a position at the rear of the animal and at the same time to take only a very small part in the formation of the lateral, ventral, or dorsal walls of the larva. This is brought about by the fact that the growths of these two abdominal imaginal discs are not very extensive; and that they actually become partly invaginated into the eighth abdominal segment, which grows much faster than they do. This is clearly seen in the section shown in figs. 25 and 27. The tenth (terminal) segment is quite small, and bears the anus; ventrally it is provided with a pair of appendages, which lie in close contact with the ninth segment, which segment is partly invaginated into the eighth. This invagination is accompanied by a marked cell-proliferation in the integument of the invaginated portion (fig. 25), and is already clearly seen in the defaecating larva; during pupal life it develops into the penis.

The segments then chitinise and are found, in this condition, in the early pupa. It is especially worthy of notice that already at this stage the two appendages of the tenth (terminal) abdominal segment have applied themselves very closely to the sternal portion of the ninth (fig. 27); indeed, while the segments of the cuticle of the pupa are, in other respects, an exact representation of the shape of the epidermis which has secreted them, yet the appendages of the tenth segment form with the sternal portion of the ninth a cuticular covering which is common to them both; an examination of the epidermal components of this compound cuticular segment, however, reveals its true nature (fig. 27). In the pupa, shortly after its formation, a curious change now takes place, which results in the formation of the penis. The cells of the sternal region of the ninth imaginal disc continue to proliferate rapidly, and grow inward, into the eighth segment; the extension is very rapid, so rapid, indeed, that after about six hours the invagination has extended forwards as far as the posterior border of the sixth segment; the process continues, and does not cease till the invagination has extended, along the mid-ventral region, well into the fifth abdominal segment.

Early in the process of invagination a cavity is developed in the mass of cells; and at the terminal (anterior) end this cavity dilates, to form a small sac, the vesicula seminalis (fig. 27), which is, therefore, formed from deeply invaginated epidermal cells, and is in no way to be regarded as a mesodermal structure. In the six-hour pupa, though already clearly defined, it has, nevertheless, not attained a very pronounced size; but some twelve hours later, it is quite a prominent bulbous dilatation at the anterior end of the penis.

The penis is thus a structure composed of the sternal portion of the ninth segment, and the appendages of the tenth, and the whole organ is produced simply by a massive ingrowth of cells of the ninth segment, forwards, along the ventral body wall.

Already in the earliest pupae the transference of the appendages of the tenth segment to the sternum of the ninth is clearly visible, but it is not till well within the second day that the distinct development of a joint separating the two is evident. Early in the pupa the two appendages unite to form a simple tube, but exactly how this takes place I have not been able to observe.

The penis is, then, a simple tube, consisting of two portions, a proximal, representing the sternum of the ninth segment, and a distal shorter portion, developed from the appendage of the tenth segment. The distal segment is seen, in the pupa, to be invaginated into the ninth; and both the segments are provided with a pair of long tendons, which serve to withdraw the distal joint into the one preceding it, and, finally, the whole structure into the abdomen. In this condition the organ is seen during later pupal life, and the ventral termination of the abdomen of the male, though really so totally different from that of the female, has, nevertheless, a curious resemblance to it. This is due to the fact that development of the male copulatory organ is mainly a process taking place within the abdomen, after the pupa has been formed.

This internal development of the tenth and ninth segments is accompanied by a number of changes in other abdominal segments, which result, in part, in the formation of the accessory copulatory organs of the ninth segment, or in the modifications of the segments to aid in the eversion of the penis. In the larva shortly before pupation, the ninth segment develops terminally a pair of great "beak-like" clasping forceps, which have a very important accessory copulatory function, while the sternal regions of the seventh and eighth segments, which have not kept pace with the extension of the tergal region of these segments, become pushed forwards and are partly invaginated as the penis develops (fig. 26).

Shortly after the penis adopts its adult proportions muscles become developed within it.

The histological processes underlying the changes will be dealt with later in connection with the development of the integument.

The general blackening of the cuticle of the pupa commences some three and a half days (in summer) after the last larval moult, and is complete about twelve hours later; the wasp remains enclosed in the pupal sheath for twelve to twenty-four hours longer, and then, splitting the thin sheath which imprisons it, escapes.

B.—The Integument (Histological Development).

In the newly hatched larva the integument has reached a state of development, which it retains with but small changes throughout the feeding period. The ectoderm consists, for its greater part, of a single layer of cells which are of two kinds; there are the large cells, less numerous than the other type, but occupying a greater part of the integument—the true "larval-cells;" and, secondly, there are the narrow strips of integument consisting entirely of smaller more embryonic cells—the centres from which the imago will later develop—the imaginal discs of the integument; indeed, at this early period the rudiments of the wings, legs, mouth appendages, antennae, and even of the eyes are clearly recognizable, while the areas from which the general body surface of the imago will later develop are very prominent.

It is to the development of the general body integument that we will first give our attention; this will be followed by the description of the formation of the legs, wings, antennae, and mouth appendages; and, finally, the most astonishing of all the integumental changes, the development of the compound eyes and ocelli will be described.

In the newly hatched larva the cells of the imaginal discs of the general body surface are small, short, and columnar, and closely packed side by side (fig. 10); their protoplasm is clear, and their nuclei are very large. As the larva grows cell division takes place, so that in the larva, at the time it defaecates, the integumental imaginal discs contain about four times the number of cells that we see in the newly hatched larva. Whether these cell divisions occur during the moulting period, or whether they occur gradually throughout larval life I am unable to say. Even this extensive multiplication is not sufficient, however, with absence of actual cell growth, to enable the cells of the imaginal discs to maintain their early appearance and at the same time retain their function of forming an unbroken body layer, such as is necessary in the secretion of a new cuticle in the period just preceding a moult. The difficulty is overcome by the cells gradually assuming a curious shape; their outer ends develop into thin flat discs their inner ends containing the nucleus become long and narrow. Thus, while the outer portions of the imaginal embryonic cells combine to present an unbroken surface—a true pavement epithelium—the inner ends, which give the predominating appearance to the disc, are long and narrow and separated by wide spaces. The large specialized larval cells, on the other hand, do not undergo these changes; on the contrary, they retain their early shape and number, and the only visible change which they undergo is a great increase in size, an increase approximately proportional to the growth of the larva as a whole.

These large larval cells of the imaginal discs co-operate during the feeding period to form the various cuticles. When newly formed, the cuticle, which is simply a direct secretion from the ectodermal cells, embraces these very closely; gradually it loosens itself, when the integument begins to secrete a second cuticle, inside the first, the two cuticles being very clearly visible in sections through the integument (figs. 47, 55).

At the time when the larva begins to defaecate the ectodermal cells begin to enter upon a period of profound changes. The nuclei have become very large—indeed, their growth appears to have kept pace with that of the whole cell —but the chromatic contents appear curiously disorganized. Each contains a relatively gigantic nucleolus. Then follows a period of cytoplasmic disintegration. The entire cell contents break up into numerous minute globules (figs. 28, 29) which have a curious resemblance to nucleated cells, each consisting of a clear outer zone, and containing a heavily staining body. They are, however, purely disintegration products of the large cells and are not to be confused with the leucocytes, which are much larger than these globules; their curious construction is probably due to some obscure physical condition of the disintegration products of the cell. These globules break loose from the cell, and are apparently dissolved in the blood.

The disappearance of the larval cells is not, however, entirely one of chemical disintegration; definite phagocytosis of the cells also occurs, but its action is quite secondary to that of the chemical disintegration. Indeed, it is improbable that there are at this stage enough leucocytes in the blood of *Nasonia* to bring about the destruction of the larval integument—not to mention the destruction of other larval organs That the process does occur, however, is quite certain, leucocytes may frequently be seen lying upon or within the disintegrated cells, and filled, at times, with degeneration globules, which they have recently ingested (fig. 31). They are the Körnchenkugeln of Weismann.

Sometimes the cell contents do not break up into these minute "pseudo-nucleated" globules, but the whole mass undergoes granular degeneration and produces a large ball (fig. 30), which, after lying for some time within the cell membrane, breaks loose, and tumbles into the general body cavity; a few globules generally remain within the cell membranes, which now appear as irregular, empty hulks, below the developing imaginal integument. Sometimes, again, the cell contents may degenerate into large hyaline spheres, about the size of leucocytes, each containing several heavily-staining granules (fig. 28).

In the body cavity the big granular spheres are fallen upon by the leucocytes, and by the intervention of these, and to a certain extent, apparently, by a process of solution, they gradually disappear. This type of cell disintegration is especially clearly seen in the larva about sixteen hours after defaecation.

The process of integument destruction lasts nearly a whole day; the cell contents first disappear, leaving only a thin cell membrane, which, in turn, eventually disintegrates

Accompanying these changes in the integument there is a total renovation of the underlying somatopleure. The larval somatopleural cells are greatly overgrown, and present a large nucleolus. Smaller embryonic cells, which have evidently lain dormant within the somatopleure, begin to proliferate during the period just preceding defaecation, and growing at the expense of the larval cells which they absorb, finally redevelop into a new somatopleure. The splanchnopleure, covering the internal organs, undergoes similar changes.

Meanwhile the imaginal discs have become active, and, while the cells undergo further multiplication, begin to encroach upon the places occupied by the disintegrated larval cells, eventually replacing these entirely. The discs grow out in all directions; the outer, most actively migrating cells often show amoeboid processes (fig. 29), and it may be by this method of locomotion that the cells advance. Sometimes they grow right over the dead larval cells (fig. 28); at other times they seem to be unable to cross them, and have to await the complete destruction of the larval integumental cells before they can advance further (fig. 32).

During the last hours of larval life, therefore, the integument consists of areas of proliferation, the cells of which, growing outwards, are actively engaged in replacing the disintegrated larval cells, or awaiting the total destruction of these.

Eventually the imaginal discs of the integument meet, a cuticle is secreted and the larval moults, disclosing the pupa.

At times leucocytes, having disposed of the remains of the larval tissues, are seen crammed with larval *débris* lying among the proliferating imaginal cells, and evidently providing, by their disintegration, nourishment for the surrounding cells (fig. 31). Sometimes, also, numerous of the large hyaline degeneration globules are seen in similar situations (fig. 31).

The integumental cells, unable to extend further, now begin to undergo structural changes; at first spindle-shaped (fig. 30), they soon begin to change their general form; in some parts of the integument, especially that of the abdomen, the cells are small and cubical, their outer surfaces very regular; the chitin secreted from them in this region is quite smooth. Along the dorsolateral regions of the pupa the cells are generally rather elongate. In the antero-dorsal region of the thorax (especially in the region of the future pronotum) this condition is especially clearly seen. Here the outer ends of the cells develop broad swellings, giving the cells a hammer-like appearance; from these swellings the thick chitin in this region becomes secreted. A somewhat similar condition is seen right at the posterior end of the abdomen. The ectoderm of the propodeum and metathorax is especially remarkable, being in the form of a great accumulation of ectodermal cells, several layers deep, all crushed together, and thus accounting for the contraction which external features show has gone on in this region.

The secretion of cuticle now goes on very rapidly, and about four hours after pupation, forms a layer nearly as thick as that of cells which are secreting it. The cells from which the cuticle is being secreted, moreover, do not, as a rule, present a perfectly smooth surface, but become so disposed as to form a mould on which the cuticle of the imago can shape itself, and the various depressions and bosses, and other sculpturing with which the imago is ornamented, as well as the hard bristles and claws, and even the delicate hairs (pubescence) are to be regarded simply as chitinisations on the surface of these cells, or on parts of them. The "spiral" thread of the tracheae, as will be described later, is similarly merely a chitinisation of a previous protoplasmic "mould." The small sculpturings on the body surface generally require only a single cell to act as a mould for them; this is very clearly seen, for example, on the head (fig 33), the dorsal part of which shows forwardly projecting scale-like bosses, while on the antero-ventral part these project upwards; and the cells, in early pupae, can be distinctly seen, one under each boss, and all disposed in such a way as to present a "scale-like" appearance similar to that of the imaginal cuticle which they are secreting. The larger sculpturings, as well as such structures as claws and large spines on the legs, are, as a rule, moulded upon a number of cells (fig. 34).

Bristles, on the other hand, are unicellular structures. Their formation can be especially clearly seen on the ovipositor and posterior extremity of the insect. The ectodermal cells begin to elongate and develop a point at their free ends; the elongation becomes more and more marked till the cell assumes the slender form of the bristle as we see it in the imago. Then it begins to chitinise (fig 35). The insertion of such a bristle on the cuticle of the imago is always strengthened by a small ring-like supporting structure (fig. 35), and the protoplasmic mould even of this support can, if the hair and cell is observed at the right moment, be clearly seen

The development of minute hairs (pubescence) is especially curious. The process can be clearly observed on the second maxillae (labium). Here the ectodermal cells develop a number of long delicate processes, giving the cells a curiously frayed appearance at their terminations (fig. 24). Each of these processes then chitinises, to form a single hair. A single cell therefore acts as a mould for a number of minute hairs and the co-operation of a number of such cells produces the rasp-like pubescent structure which one finds on the "tongue-like" labium of the adult *Nasonia*. The chitinisation of the epidermal cells continues throughout pupal life, and the process does not cease till the whole of the cells have been converted into chitin. A cellular ectoderm is, therefore, absent in *Nasonia*, except in the region of the great eye.

The extraordinary accumulation of epidermal cells in the region of the propodeum results in the formation of an especially thick chitin layer there. Indeed, so active is the process of chitin secretion in this neighbourhood, that sections actually show minute liquid globules issuing from the chitin-secreting cells.

The cells, on the other hand, which are in the region of the future joint membranes, do not form a hard chitin, but produce a tough, but flexible, somewhat corrugated membrane. This is especially clearly seen in the neck region, and at the points of junction of the legs with the thorax (fig. 41).

The somatopleural mesoderm, so far as I can observe, always undergoes a renovation during the metamorphosis, and eventually persists as a delicate membrane with prominent nuclei, immediately below the chitinised ectodermal cells.

The metamorphosis of the general body integument, then, closely resembles that described by Pérez in *Calliphora*. In that insect, however, the imaginal ectoderm extends over the cells of the larval ectoderm, which do not disappear till much later. Though cytoplasmic degeneration, somewhat similar to that of *Nasonia* occurs, phagocytosis is much more prominent, and the phagocytes attacking the integument cells are, generally, already strongly gorged with phagocytised muscle tissue (sarcolytes).

The Phragmas.—During the pupal period the integument undergoes a number of changes which result in the formation of the phragmas—ingrowths of the integument serving for the insertion of the muscles. The phragmas are of two kinds: there are the true phragmas, which are actual invaginations of the integument (fig. 43); a second type of structure which may be designated a "false phragma" is essentially an ingrowth of the edge of a segment into the body cavity, below another segment which now overlaps it. An excellent example of such a "false phragma" is the anterior part of the mesothoracic tergum, which, as already mentioned, is simply a prolongation of the mesothorax beneath the prothorax. The great phragmas of the ovipositor also belongs to this class. A false phragma, then, is a downgrowth of integument, which consists of only a single layer of cells. The true phragmas, on the other hand, are invaginations of the integument, generally hollow at first, and consist, of course, of a double layer of integument. They are found early in pupal life, and after some thirty-six hours chitinise, the chitin being secreted between the two layers.

In the abdomen of the female a number of these phragmas are developed in connection with the ovipositor. They are rather short, and on them originate the great muscles of the ovipositor.

The thorax and propodeum are provided with a number of transverse phragmas, for the insertion of the great thoracic muscles, and those of the legs and wings. One such phragma runs transversely just behind the scutum of the mesothorax; below the metathorax runs a transverse horizontal phragma.

In the neck there is also a phragma, being a hoop-like forward and backward extension of the prothoracic shield, all round the neck.

But the most remarkable of all are the great cephalic phragmas, which give attachment to the muscles of the antennae and mouth appendages (fig. 43). Early in pupal life a long tube-like invagination of the integument takes place on either side of the face, half-way between the mouth and the antennae. These invaginations grow upwards and inwards and terminate at the rear of the lower part of the brain. Meanwhile a second pair of tube-like invaginations has been formed at the rear of the head, a little below the neck; growing inwards they meet the anterior pair of invaginations. Since both pairs have a narrow lumen, we have the curious fact that at this stage a pair of long narrow canals run right through the head from front to rear, well above and either side of the mouth! The secretion of chitin, however, soon takes place and the canals are obliterated, being gradually replaced by an exceedingly powerful rod of chitin.

The integument on the three thoracic segments undergoes, during larval and pupal life, a number of remarkable changes which terminate in the formation of the wings and legs. The histogenesis of these structures will be considered first; that of the other appendages of the insect, which usually resemble it closely, can be considered more briefly.

The Legs.—The imaginal discs of the legs are clearly visible in the earliest larvae. Here they occur, a pair in each of the three segments, as rather extensive but sharply defined areas rather thicker than the remainder of the integument, and lying on each side of the nerve cord, on the ventral side of the animal. The cells composing the discs are long and rather narrow (fig. 10). At the end of larval life the cells have increased greatly in number, and, as a result of the growth of the surrounding integumental cells the imaginal discs have become invaginated below the surface (figs. 2, 5, 6). On the base of this invagination the cells lengthen and divide to form a large prominent papilla. In the resting larva this papilla begins to increase in size, and soon grows out of the invagination as a hollow appendage, dragging the mesoderm after it.

Cell division by mitosis is very rapid, and the developing leg grows downwards, so that in the larva, before hatching, very well defined legs are present, hidden beneath the larval cuticle (fig. 3). The integument of the legs in common with that of the rest of the body develops a cuticle, the completion of which is followed by the moulting of the larva. So rapid has been the growth of the appendage, that its integument becomes slightly folded in places to prevent further growth within the limited space afforded by the larval cuticle. This folding is very easily confused with the segmentation of the leg, a process which is not completed till some twelve hours later.

The general features of the formation of the legs have already been described in connection with the transformation of the external characters of the insect. Among the most characteristic of these changes are to be mentioned the development of the bristles, spines and claws, the deepening of the joints, and especially the curious shrinking of the ectoderm, which transforms the thick ungainly appendages of the late larval and early pupal stages into the slender structures so characteristic of the imago.

This shrinking of the legs is produced by a shortening and closer packing of the ectodermal cells. In the late larval stage these cells are long and slender, and are loosely arranged, but after pupation, the cells shorten considerably, become rather thicker, and much more closely packed together—they change from a loose columnar to a firm cubical epithelium.

Segmentation of the leg in the larva, though clearly visible, is nevertheless little more than a series of constrictions due to a slight shortening of cells in this region. In the eight-hour pupa the constriction has become more marked, and even the tarsal joints are now very clearly defined (fig. 16). More marked segmentation is produced by a slight invagination of the cells of the constriction rings, a process which is rapidly followed by the secretion of a chitinous cuticle. In the thirty-six hour pupa this process has advanced considerably. Chitinisation continues for several days, till the whole of the ectodermal cells, with the exception of many of the bristle cells, become converted into the hard shell of the legs.

The formation of bristles is rendered possible by the shrinking of the legs; it begins about eight hours after pupation and is practically complete thirty hours later. The development of bristles and spines has already been dealt with in connection with the development of the general body integument. Many of the bristles of the legs, however, take on a special tactile function. This is particularly clearly seen on the first tarsal segment of the first leg (fig. 19). On the lower side of this segment is a row of about twenty bristles, the lower ones large, the upper shorter. In suitable preparations the lower ones can be clearly seen to be connected with nerve-fibres, branches of a moderately large nerve which passes down the leg. The bristle cell does not chitinise entirely, but a protoplasmic base is left, below which is a small mesodermal cell which attaches itself by a thin "collar" to the chitinous integument of the leg immediately surrounding the bristle. From each of these cells a process is given off backwards to the nerve of the leg. It seems that this minute process is merely a neurolemma (since it stains feebly with haematoxylin, which the nerve fibre will not do), and this neurolemma protects an even more delicate nerve fibre This nerve fibre can actually be seen leaving the outer part of the mesodermal cell and communicating with the bristle cell, within the collar developed from the former (fig. 19).

I have not been able to determine exactly the function of the whole armature of bristles, which are so numerous on the legs, that they aid the insect in clinging to objects is undoubtedly true, but it seems quite possible that a very large proportion of them have also a definite tactile function. In the case of the first tarsal joint this is certain; scattered bristles on other parts of the tarsi also have nerves connected with them, but the structures dealt with are so minute, that I cannot definitely say whether similar nerve-endings are present on all of them.

Lowne has shown that the general integument of a fly is sensitive to touch. The same author describes bipolar ganglion cells lying in close contact with the tactile bristles; I suspect, however, that they are really either ectodermal "receptor" cells, which have produced the bristle, or mesodermal cells acting as a neurolemma, which encloses the delicate nerve fibre that terminates on the bristle. Bipolar nerve cells in this position are quite absent in *Nasonia;* but the mesodermal cells which lie beneath the tactile bristles closely resemble such cells, the enclosed nerve fibre being very difficult, or often impossible to detect, partly on account of its feeble staining capacity. But when the development of the tactile organs is followed out, the nature of these cells becomes quite clear. In the eye they are ectodermal in origin (see "Organs of Vision"); in the legs and antennae they are mesodermal, and the nerves which grow towards them from the brain or ventral nerve cord are quite devoid of cell nuclei, consisting merely of nerve fibres, whose nuclei remain in the central nervous system.

As Lowne did not observe the development of the tactile sense organs, he naturally put the more obvious interpretation on his observations. Indeed, it seems to be the generally accepted view that the cell lying below the tactile hair is a nerve cell; an examination of the embryology of the structures concerned will, however, show this view to be erroneous. I shall refer to this again later.

Leucocytes, containing large amounts of *débris* from the histolysed tissues, enter the legs in an early stage in their formation. Sometimes the narrow lumen of the leg contains these cells in large numbers; occasionally one may be seen among the loose epithelial cells of the leg. In the early pupa the leucocytes appear quite healthy, although heavily gorged with larval tissues; but gradually they disintegrate, or recovering, wander away, and are no longer seen here in a two-day pupa. The disintegration will be described more fully in connection with the blood.

A single tracheal vessel enters into each leg soon after its formation (fig. 65)

The formation of the muscles of the leg and of the great tendon will be more conveniently considered in connection with the muscular system.

The development of the last tarsal segment is worthy of special attention. Already in the eight-hour pupa the segment is slightly larger and wider than those which precede it. As development proceeds this process continues, producing a claw-bearing segment considerably wider than the others. The ectodermal cells, moreover, do not remain as a single layer but proliferate, producing two masses of padding tissue, very similar to that which is formed in the bulging segment of the antennae. These masses are clearly visible in the pupa of thirty-six hours. The epidermal cells on either side of them, and also at a place on the ventral side slightly proximal to them, grow out in the form of large claws. Chitinisation then takes place. The cells of the three claws almost totally disappear; the pads, however, secrete only a very thin membrane of chitin, which arranges itself in two pairs of long pads, structures which are probably to be considered as adhesive organs. They are shown clearly in fig. 46, which is from a pupa of four and a half days. The distal part of these pads is totally devoid of cells, the padding cells being confined entirely to the main portion of the segment. The proximal part of the padding tissue is syncitial in nature and on it is inserted what appears to be a tendon (fig. 46). It is quite possible that a pull of this tendon would draw back the padding tissue and apparently also the thin chitin which it has secreted. If the joint had been placed previously on some solid object it is conceivable that a partial vacuum might be created between the four adhesive pads and the object, thus enabling the wasp to cling to a smooth surface. The capacity of chalcid wasps for clinging to window glasses is, of course, well known to all who have collected them.

The Wings.—The general features of the development of the wings have been described above; it remains to describe now the histological changes which they undergo.

The imaginal discs of the wings are seen even in the larva ot the first instar as two pairs of rather pronounced thickened areas in the second and third thoracic segments. Cellular proliferation takes place during larval life, and, just as in the legs and other appendages, the excessive growth of the surrounding "larval" cells produces an invagination of the discs; rapid mitotic cell division during the resting period results in an evagination of the disc, the underlying mesoderm being, as usual, dragged into the structure. The epithelium of the wing consists of a single layer of elongated cells; these cells, in order to present a greater surface area, frequently develop on their free surface in the larva shortly before pupating, distinct hammer-like thickenings.

The secretion of a cuticle, simultaneously with cuticle development over the rest of the animal is followed by the pupal moult.

The contraction of the wings, as already described, results simply from a closer packing of the cells. In the early pupa a cell of the fat-body often passes into the cavity of the wing, helping to nourish that structure; the mesodermal cells are seen undergoing mitotic division.

After twenty-four hours the cavity of the wing has been almost obliterated. This is the result of at least two factors: firstly, the cells shorten somewhat, the peripheral pull dragging the two surfaces nearer together; secondly, they begin to undergo a remarkable process of wrinkling on their free surface, as a result of which the lower part of the cell becomes forced backwards. This wrinkling can already be seen commencing in the four-hour pupa; in the thirty-six hour pupa it is very far advanced, and the free surface of the cells which now present great folds, begin to secrete chitin which is itself, therefore, strongly folded. Many of the cells, however, in addition to forming folds, have also developed a hair-like process on their free surface; the cuticles secreted on these processes are the fine hairs of the insect's wing (fig. 37).

Other cells, again, on the anterior part of the wing lengthen greatly, and extending beyond the surface of the wing form bristles. Greatly hypertrophied cells on the hind wings produce the clinging hooks (fig 38).

Towards the end of pupal life the greatly folded cells have lost the whole of their cytoplasm, this having become transferred, apparently, into the thin chitinous cuticle. The cell walls, however, are still visible, as are also the cell nuclei; some of these, indeed, show no visible signs of degeneration; others, however, are distinctly abnormal, having lost practically the whole of their chromatin contents (fig. 37). By the time the insect emerges from the pupa all the nuclei have disappeared, except a number on the outer edge of the wing, these persist throughout the life of the wasp in a half disintegrated state; their presence can easily be revealed by staining the wing of a properly preserved insect (fig. 38). The outlines of the cell of the pupal wing are also clearly visible around the border of that of the imago; they are beautifully seen in the great fastening hooks of the hind wings, as long projections into the wing, and evidently give special strength to these structures (fig. 38).

By this extensive folding of the free surface of the cells, the great extensions in the size of the wing take place; so pronounced indeed is this, that, as already mentioned, the wing directly after the imaginal moult, expands to an area sixteen times that of the pupal wing.

The obliteration of the cavity of the wing, as described above, however, is not complete; on the contrary, the first wing preserves an anterior (marginal) and a median longitudinal "sinus," in the form of two great channels passing down the wing (fig. 44). The anterior one is bifurcate distally. The hind wing presents only one such channel. These channels are the "clear spaces" described above as visible in a surface view of the wing, and into these channels pass the tracheoles of the wing; leucocytes are also seen here during early pupal life; they disintegrate later (just as they do in the other appendages), but some may be seen even into the fourth day of the pupa.

If a newly found pupal wing be examined in sections a remarkable thing is seen. The mesodermal cells a little beyond the base of the wing begin to proliferate, and then extend as a long column of cells right down the great fissures in the wings (fig. 45). No such structure, however, ever extends (in *Nasonia*) into the median channel of the fore wing, though this channel does lodge tracheoles and leucocytes; it remains indeed merely as a "pseudo-nervure," while the marginal structures in both wings develop into true nervures. The cells of these columns are elongated and "brick-like" in shape; the growth of the column is very rapid and is complete several hours after pupation. Late in pupal life the internal "lining" of the great channels begins to chitinise slightly; the chitin is pale yellow in colour, and to this the characteristic colouration of the nervure is due.

To what the unfolding of the wrinkled wing at the emergence of the wasp is due is difficult to say. While not attempting to discuss its cause in *all* insects, I may say that the usually accepted view, *viz.*, that it is produced by the passage of air into the tracheae of the wing, must be discarded in the case of *Nasonia*. Here the tracheoles are very delicate, somewhat twisted tubes, quite incapable of altering the shape of the wings which bear them. It seems much more probable that the straightening is due to the turgidity of the cells of the great ectodermal extension into the channels, and that the wings remain firm, later, as the result of the action of the air on substances contained in the chitin of the nervures.

In connection with the small "stigmal-vein" of the fore-wing, a remarkable structure is developed, the interpretation of which is very difficult. On the distal part of the veins are developed four rounded globules (fig. 39), the distal pair rather smaller than the other two. They are well known to workers on chalcid wasps, and are frequently used in classifications. But if a stained wing is examined under a very high power each of these globules is seen to contain a heavily staining sphere (figs. 39, 40) attached to a small conical piece of protoplasm, the base of which is in turn attached to a long fibre. The fibre from each globule passes inwards, and becomes lost in the substance of the stigmal vein. It seems probable that the whole structure is one cell, of which the process and the conical portion represent the cytoplasm, while the sphere is the nucleus surrounded by a very delicate layer of cytoplasm. The long process, of course, immediately suggests a sensory structure; the nerve fibre being, as usual, almost impossible to detect, and lying within the weakly staining process, which acts perhaps as neurolemma. If this interpretation be correct, then it is not impossible that the structures concerned should act as speed-detecters. Increased speed of flight would be produced by increased rate of vibration of the wings; this would result in a greater centrifugal pull on the free (spherical) part of this remarkable structure; or, what is more probable, it would result in a greater frequency of the striking of this body against the walls of the globule, and it is conceivable that this would affect the nerve fibre which terminated in it.

The Mouth Appendages.—The general features of the histogenesis of the mouth appendages are so similar to those of the thoracic, that a brief description will suffice here.

The imaginal rudiments of these structures are clearly visible in the first larval instar (fig. 47); in their condition of development the labrum and mandibles are already much in advance of the condition in which we find the thoracic appendages; *i.e.*, they are no longer merely ectodermal thickenings, consisting of embryonic cells, but have now become invaginated well into the cavity of the head.

The imaginal discs of the labrum are a pair of solid ectodermal ingrowths, situated at either angle on the fore-part of the mouth. Their development during the larval and early pupal periods is quite similar to that of the thoracic appendages, *i.e.*, the cells proliferate, grow outwards, forming a cavity behind them as they do so, and drag the underlying mesoderm after them. The general features of their development have already been described.

The mandibular imaginal discs (fig. 47) are particularly interesting. Each consists of a sac of ectodermal cells (lined, of course, with mesoderm), and invaginated well into the cavity of the head. The floor of the "sac" is many cells thick, the cells themselves being rather smaller than the larval integumentary cells. On the "floor" of the invagination is a small number (about nine) of very remarkable cells; they are club-like in shape, and each bears a long cytoplasmic extension outwards. These processes are so arranged that they possess, together, the shape of the larval jaw, and it is from the termination of these remarkable cells that the minute stylet-like mandible of the larva is secreted. This is seen clearly in fig. 47, which is taken from a larva shortly before entering the second instar. The functional jaw is no longer in communication with the cells which have secreted it; these cells, on the contrary, are now secreting a second mandible, within the first, and the latter will be cast off at the larval moult.

We see, then, that the larval mandible is formed from the same set of cells which produce the mandible of the imago. The jaw of the larva must therefore be regarded as homologous, in part, with the jaw of the mature insect. It is, of course, quite conceivable that this might not have been the case; however, the fact that it is so can lead to important conclusions, which will be considered in the second part of this paper. The same thing will be seen later, in connection with the antennae.

During the feeding period of the larva the mandibular imaginal disc grows in size; at about the middle of this period the disc has become partly everted, and the projecting portion has the shape of the jaw of the last instar. On account of the much greater size of the jaw at this stage, it is necessary for a much larger part than hitherto of the imaginal disc to take part in its formation, and this is the reason for its precocious evagination.

During the resting stage the mandibular disc grows rapidly, the cells dividing mitotically. So far as I could observe, the long club-like cells of the disc in its first instar become modified during larval life into cells which do not differ visibly from the others of the madibular disc, *i.e.*, cells which have become specialized into secreting a certain structure may apparently (perhaps as a result of the act of secretion) become modified so as to resemble neighbouring cells, and then co-operate with these in the secretion of another (sometimes unlike) structure. The observation, if correct, would be of considerable theoretical importance. I cannot, however, state with certainty whether these earliest specialized cells persist throughout larval life.

Early in the resting period the mandibular palp already mentioned above is distinctly seen. The disc grows rapidly by mitotic division of the cells, and drags the mesoderm after it.

The remainder of the development of this, and of the other appendages of the mouth, closely resembles that of the legs, and need not be described further here. It is only necessary to add that the imaginal discs of the first and second maxillae are present in the earliest larvae, and do not differ, except in position (being closely applied to the mouth) from the leg discs.

The Ovipositor.—The early stages in the formation of the ovipositor are identified with those of the legs, *i.e.*, the imaginal rudiments, present in the early larvae as ectodermal thickenings, become invaginated into the abdominal cavity (fig. 2). In the resting period they grow outwards, dragging the mesoderm after them; rapid cell division, by mitosis, results in the great extension of these appendages, along the ventral body wall, as has already been described fully above. The ectoderm of these appendages is only one cell-layer in thickness, and the cells themselves are generally long and narrow. The third appendages differ from the others, however, in being several cell-layers in thickness; they are not hollow, as are the others, and are fused with the body wall. Into the hollow appendages, as usual, migrate leucocytes, which disintegrate there during the pupal stage. The second appendages in the larva seven hours after defaecation have already become closely approximated, and the cells on their adjacent halves have forsaken their long columnar shape and are now cubical; this portion of the appendage is in process of invagination into the outer part.

In the early pupa, the cells of the developing ovipositor begin to lose their columnar shape, the characteristic of the growing stage, and now become cubical, and rather small in volume, *i.e.*, the ovipositor as a whole, having reached its condition of maximum growth, now begins to differentiate. The cells, themselves, become more closely packed together, and the long appendages shrink, just as we saw, above, in connection with the legs and wings.

The second appendages meanwhile have fused, and now enclose a cavity. Since the inner half of each of the second appendages has become invaginated into the outer half, it follows that the tube formed by their fusion must be lined internally by the ectoderm

Shrinking of the appendages continues; in the thirty-six hour pupa the second appendage is no longer recognizable as a compound structure, it appears simply as a tube, lined by a single layer of ectodermal cells, the cavity containing mesoderm.

During the third day chitinisation commences The outer portions of the first appendages chitinise strongly; their inner parts, however, remain as flexible membranes, similar to those of the leg joints, neck joints, etc. (fig. 42). The compound second appendage chitinises in a very remarkable manner. The cells at its tip have previously arranged themselves so as to present a serrated tip to the ovipositor; chitinisation of this results in the characteristic sawing extremity. The remainder of the compound appendage becomes semilunar in section; the two outer thirds chitinise heavily, and the chitinous prisms so formed are connected by the median portion, whose walls develop into tough membranes, and enclose a quantity of mesodermal tissue. In side view the chitinised ovipositor shows a very pronounced "spiral" pattern, not unlike that of large tracheae.

The hard chitinous sheaths and the tough membranes of the first and second appendages thus enclose between them a firm, yet pliable passage, down which the eggs pass during oviposition.

An important part of the female egg-laying apparatus is the short appendages of the last abdominal segments; the general nature of these appendages has been described in connection with the general features of the insect; it remains to point out the nature of the tactile organs with which the appendage is so well supplied.

The general features of the development of the appendage are identical with those of the body integument. The bristle-secreting cells, however, do not entirely chitinise; on the contrary, they seem to grow in size, and growing backwards from the bristle, pass well into the cavity of the appendage, remaining in connection with the cell only by a long delicate process (*cf.* fig. 50). A large nerve enters each appendage, then breaks up into nerve fibres, which communicate each with a bristle cell. I could find no trace of an intervening mesodermal cell, similar to that described in the tactile bristles of the leg or antenna. The whole appendage, however, is filled with a mass of mesodermal padding tissue, which evidently acts as a sufficient protection for the delicate nerve fibres.

It seems scarcely necessary to point out again that the large cell lying beneath the tactile bristle is not a nerve cell, as it is usually believed to be, but that it is merely the ectodermal cell (receptor cell), from which the bristle has been formed. The cell is not an element alien to the bristle, but rather is the bristle to be regarded as a special part of the cell which acts as an intermediary between the cell and the environment, much as do the taste-hairlets at the free ends of the cells of mammalian taste-buds

The Male Copulatory Organs.—The visible cellular changes which underlie the formation of the penis are very simple; first the cells, in the early pupa, adopt the usual columnar (growing) shape; in the pupa two days old they become cubical, and chitinise a day later.

The cells of the anterior dilation of the cavity of the penis, the vesicula seminalis, are quite different in shape; they are long and narrow, and form a thick wall around the vesicle.

The Antennae.—At the front of the head are formed a pair of appendages, the antennae, which are quite different in nature from those appendages above described. Below them an outgrowth of nerve fibres is formed from the brain, on each side; and the fibres growing into the developing antennae terminate on modified ectodermal cells in these, the modifications of the ectodermal cells into sense cells, and indeed, of the whole ectoderm into an antenna being of such a nature as to form what must be a very efficient sensory structure.

The antennae are present in the earliest larvae—indeed, at this stage they are already more advanced than are the legs or wings, each being now in the form of a small papilla, composed of long narrow cells undergoing evagination from a previously invaginated antennal disc (fig. 47) They are, indeed, at a stage of development which the legs do not reach till the end of larval life.

During the larval period the cells of the rudimentary disc continue to divide, so that, shortly before the larva defaecates, a distinct antenna is visible on the surface of the larva (fig. 3). Already at this stage the curiously jointed condition of the mature structure is clearly indicated (fig. 36), for the ectodermal cells have not divided regularly, as is the case in the legs and wings, but at short intervals a few cells have ceased to divide for a time, and remain long and columnar, while between these the ectoderm has undergone a marked proliferation to form a solid downgrowth of very minute cells; from the latter the tissue which produces the bulging of the joints is formed—a kind of padding tissue—whilst the former, the long columnar cells, give rise eventually to the joints and constrictions between the segments of the antenna.

Already at this early stage a distinct outgrowth of nerve fibres from the brain is seen, though it does not as yet extend right into the developing antenna; a large tracheal vessel can also be distinctly seen, at this stage, within the lumen of the antennal projection (fig. 36) Leucocytes have also begun to enter.

The mesoderm still adhering to the overlying ectodermal cells, follows them as they grow outward to form the antenna. The cells do not appear, at this stage, to have undergone any marked proliferation, and consequently appear as a delicate network lining the lumen of this structure. But that the mesoderm does eventually proliferate seems quite clear. This will be referred to later

The post-defaecation period of the larva is marked by a continuation of this process, the antenna growing rapidly eventually attains the size that we see in the mature insect. The differentiation is, as yet, however, very incomplete The cells of the "padding tissue" have proliferated so rapidly that the mass develops a temporary invagination cavity (fig 36) The columnar "partition cells" have divided, and now form a narrow ring of short cells between the masses. The ectodermal cells then partake in the process of cuticle secretion which is going on everywhere in the integument at this stage, a process which, when it is complete, is immediately followed by a shedding of the larval cuticle

The antenna now contains two tracheal vessels (fig. 65), large numbers of leucocytes are present, and the nerve outgrowth from the brain has extended practically to the tip of the structure.

A rapid differentiation now takes place. The cells comprising the integument of the antenna adopt a more regular arrangement; the cells which give rise to the joints between the segments and to the proximal and distal walls of the segments proliferate somewhat, and, perhaps, on account of the presence of a hard cuticle on their outer surface, grow inwards, dividing the whole antenna into the segments so characteristic of that stage. This condition, the commencement of which is seen in the four-hour pupa, is complete in the pupa thirty-six hours of age (fig. 15).

Meanwhile the formation of bristles has been taking place. Already in the four-hour pupa a number of integumentary cells at the tip of the antenna have elongated and projected beyond the general surface of the antenna. This process is made possible by the curious shrinking, already referred to, which is seen in the developing appendages of the early pupal period The shrinking is probably due to a closer packing of the integumentary cells, which transforms the ungainly appendages of the early pupa into the exquisitely moulded structures of the imago. Twenty-four hours later the process of bristle formation has become completed over the whole antenna, and the secretion of new chitin begins.

The integumentary cells at this stage are rather long and columnar, and leucocytes, in various stages of disintegration, may be seen lying amongst them. The leucocytes of the lumen of the antenna are also undergoing slow disintegration, by a process which will be referred to later.

At thirty-six hours after pupation the process of chitinisation has become marked; it continues for a long time, but differs in a rather important respect from what we see in the chitinisation of the general body integument. The cells do not undergo complete chitinisation, but remain partly as living cells (receptor cells), with which the antennal nerve fibres communicate. Thus only the distal portion of the bristle-forming cells chitinises; the proximal portion remains below and in close contact with the bristle which it has secreted. Even the cells which form the general integument of the antenna do not chitinise completely.

Meanwhile the mesoderm has been undergoing remarkable changes. The fibres of the network already referred to have increased in length; the cells have increased considerably in number and also in size, and they now become so disposed as to occupy a position below and in close contact with the bristle secreting cells; a very delicate connection can actually be seen, joining the mesodermal cell to the bristle cell above it; so intimate, indeed, is the communication between the two that it gives the appearance of a large binucleate cell (fig. 49).

Meanwhile the nerve of the antenna has grown in size, and extended as a great "tendon-like" axis right through the antenna. Covering it is a thin layer of cells, the splanchnopleure of the brain.

In each segment of the antenna this great nerve (fig. 15) gives off fibres, so that at the tip of the distal segment, it is represented only by a loose outwardly radiating bunch of fibres; and in good preparations it is frequently possible to trace a single nerve fibre from the great antennal nerve through the padding tissue into one of the mesodermal cells which lie beneath the bristle cells; that portion of the nerve fibre between the antennal nerve and the nucleus of the mesodermal cell being protected by a fibre of the mesodermal network already described.

The mesodermal cells must therefore be regarded as constituting a kind of neurolemma for the nerve fibres; what the actual connection between the nerve and the bristle cell, a connection which must be situated in the delicate connecting piece between the two cells, is, I am unable to say. These remarkable structures are shown in figs. 49 and 51. Very often two mesodermal cells lie in connection with a bristle cell (figs. 51, 53). The apparently erroneous interpretation which B. T. Lowne placed on similar cells in *Calliphora* has already been discussed in connection with the description of the tactile organs on the legs.

At the tip of the antenna the bristle secreting cells have frequently retreated a considerable distance from the respective bristles, and only a long protoplasmic filament remains to connect them (fig. 50).

It seems scarcely possible to doubt that the structures here seen are tactile in nature

The antenna, however, is the seat of a number of other remarkable sensory structures.

In the second segment, which is rather longer than those which follow it, there is a number of curious structures, which must, I think, be regarded as olfactory organs. Of these there are ten, and each is in the form of a long tubular sac, formed by five elongated cells, each with a large nucleus, the ten olfactory sacs hanging in a ring around the antennal nerve, from the distal end of the segment, into its spacious cavity (fig. 52). The lumen of these tube-like sacs is very slender, and appears to be quite devoid of chitin. It communicates by a short duct with the exterior, the small circular openings lying in a rather deep ring-like depression immediately surrounding the joint between the second and third segments. The masses of padding tissue act as supports for the olfactory sacs. I could not observe the innervation of these organs, a fact which is partly due to the minuteness of the nerves, and to the difficulty of staining them. Nor was I able to follow their whole development—in newly formed pupae they do not yet occur; in pupae at the fifty-six hour stage they have already been formed, appearing then as long protoplasmic sacs hanging down from the distal end of the segment, rather gelatinous in consistency, and not so delicate and slender as in the adult condition. They probably begin to develop, then, at about the twelve- to twenty-four hour stage, and there can be little doubt that they are produced simply as invaginations of the developing ectoderm, accompanied by a great elongation of the cells concerned.

A third series of structures, which are perhaps to be regarded as sense cells that serve the insect in maintaining its equilibrium, is found in all the antennal joints, with the exception of the first and last. On the proximal and distal surfaces of the antennal segments the epidermal cells do not chitinise, as they do on the general body surface, but, after secreting a thick chitinous sheath, remain below and in close contact with this, as large fleshy cells, which are especially prominent in the angle between the lateral walls and the distal surface (fig. 51). Each of these large cells has the appearance of being binucleate; one of these nuclei is probably that of a mesodermal cell, the close adherence of the ectodermal and the underlying mesodermal cell having already been mentioned in connection with the cells of the tactile bristles. In fortunate preparations a nerve may be seen running to these large cells. I hope to discuss their function more fully in a later paper.

A fourth series of structures, which are perhaps to be regarded as auditory organs, can be very clearly seen on the last nine antennal joints. They are confined to the female, and each structure is in the form of a long, rather narrow, hollow cylinder, sharply pointed distally, and formed of thin, clear, transparent chitin (fig. 53). Immediately beneath these hollow cylinders lies a mass of fleshy cells; sometimes as many as five nuclei are visible, and no distinct cell walls can be recognized. What is apparently a strand of nerve fibres can occasionally be seen entering this cell mass.

These organs are very prominent on the antenna of the female, each being nearly as long as the antennal segment bearing it, and frequently projecting in a sharp point beyond it. The number in the several segments varies; the first and second bear six each; the third has eight; the next three, ten; the seventh, twelve; the eighth, fourteen; and the last, eight.

Only the first (proximal) segment of the antenna is provided with muscles (fig. 11). These run longitudinally; distally they are inserted into the upper portion of the tip of the first joint; then passing backwards, they diverge a little and, entering the head, pass downwards, and become inserted on the great cephalic phragmas. The lower portion of the wall bounding the opening in the head through which the nerves, muscles, and tracheae pass into the antenna serves as a pulley on which the antennal muscles work.

A second set of muscles is confined to the antenna; it has its origin along the posterior ventral half of the first joint and is inserted into the upper part of the base of the second. The function of this system is, obviously, to raise the greater part of the antenna, irrespective of the action of the other set of muscles.

The muscles begin to develop in the pupa of four hours; the actual histogenesis of these muscles, which does not differ from that of other muscles, will be described later.

By this process, then, there is formed the antenna of the imago, a structure which is to be regarded simply as a highly sensitive portion of the integument, modified and grown out in such a way as to permit of a maximum of efficiency in the action of the sense cells, which it bears.

The Organs of Vision.

The Compound Eye.—But of all the changes undergone by the ectoderm as it gradually develops in the larva and the pupa, the most remarkable are those which take place at the sides, and in front, of the head Here the ectodermal cells become exceedingly specialized, and, while retaining their primitive function of acting as a protection for the internal organs, as well as, to a certain extent, their capacity for secreting a cuticle, yet become modified, and disposed in such a manner that the terminations of outgrowing nerve fibres from the brain, which come to end in close relation with them, may become stimulated in certain ways by the light rays emitted from external objects, the vague impressions of which become modified, as a result of their physical mediation, into what must now be very highly specialized sensations

As a result of the processes, which begin in the embryo, and are continued right throughout larval and pupal life, the great compound eyes and the three smaller ocelli become developed.

The formation of the compound eyes will be considered first. Already in the larva of the first instar the ectoderm of the head, on either side of the brain, has begun its modified course of development. The ectoderm at this stage consists of a large number of cells disposed roughly in three layers (fig. 55). Although no examination of eyes in unhatched embryos was made, yet there can be no doubt that the cells of those layers are formed as a result of a division of vertically elongated cells, the disposition of the cells at this stage being such as to indicate that they had arisen from those of the middle layer. Several individual cells are shown isolated in fig. 54 for greater clearness. The cells of these three layers can already be distinguished morphologically. Those of the external layer are rather short and generally conical in shape; the middle layer cells are long and generally spindle-shaped, with the nucleus in their middle, while the cells of the inner layer are elongated, broad and conical at their bases, and prolonged externally into a long rather narrow process; the nucleus is confined to the lower conical portion of the cell. In all three types of cell the nuclei are alike, there is a fairly distinct nuclear membrane, and the chromatin is contained in a sharply defined karyosome. The cell cytoplasm is devoid of granules.

During larval life there is a great proliferation of the cells of the imaginal disc, unaccompanied, however, by any marked visible differentiation; so that the optic disc in the larva at the time it ceases to feed is little different from the structure as we see it in the first instar, except that the cells are ever so much more numerous, and actually smaller than in the early larva. I could find no evidence of renewed differentation of optic disc cells from unmodified head ectoderm during larval life, such as occurs, according to Günther (1912), in the developing eye of *Dytiscus marginalis*. On account of the great crowding together of cells at this stage, it is very difficult, except in places where they have been accidentally loosened, to observe the actual structure of the individual cells. No marked difference can, however, be noticed between these cells, and those of the early imaginal disc.

About the time when the larva ceases to feed, the cells begin, as a result, probably, of their mode of division, to adopt the arrangement in groups somewhat as we see them in the adult wasp. The basal cells, with a very elongate oval nucleus whose chromatin is arranged in scattered granules, which apparently develop the rhabdome, can now be seen extending right to the external surface, and the cells of the middle layer are seen to surround this cell in groups of seven. These are the sheath (1) cells which, with the basal cells, form the developing ommatidia. At the time when the larva begins to defaecate the cells of the external layer have extended throughout the thickness of the disc, and can be seen undergoing longitudinal (vertical) fission, their nuclei being retained in their outer portions (fig. 56). At their bases (distal ends) can be seen, in good preparations, four minute cells, which have probably been budded off from them. These are the undifferentiated vitreous cells, which later become so prominent. In the larva at the time of defaecation, a single pair only, as a rule, of the elongated outer-layer cells can be seen between adjacent ommatidia. Their disposition is such as to show very clearly that they have quite recently undergone longitudinal fission (fig. 56). At times, though very rarely, a third such cell can already be seen connected with the developing ommatidium. The most obvious feature of the developing compound eye at this stage, and for the whole of the next day, is the closeness with which the cells are disposed, making accurate observation of the development impossible except in places where the cells have become artificially loosened.

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(1) They are, as a rule, spoken of as "retinula cells." This is, however, due to a misconception of their function, and they will here be spoken of simply as "sheath cells."

This process of longitudinal division of the cells surrounding the ommatidia continues for a time after defaecation, till four such cells are formed round each. In larvae eight hours after they have defaecated this process is complete (fig. 57). At this time there have also been formed, almost certainly from these same outer-layer cells, a pair of rather small clear cells, developed at the outer end of each ommatidium, and generally very distinctly visible; they do not attach themselves as closely to the ommatidial cells as do the others. The four long cells which embrace the ommatidia are the developing pigment cells; during their formation from the outer-layer cells their nuclei have taken up a more internal position. The two small cells lying external to them will become the lens cells.

At this stage, then, the optic disc consists of a great number of developing ommatidia, each consisting of a large central basal cell, closely surrounded by seven sheath cells, while at the distal end of each there are four vitreous cells, and two lens cells outside these, adjacent ommatidia being separated by the four elongated pigment cells which surround these structures.

The processes described so far have consisted almost entirely in the cells adopting the position in which they occur in the adult; visible differentiation has not proceeded beyond the rough assumption of size of the adult cells. The remainder of the development consists of a change of the general disposition of the optic disc as a whole (due chiefly to an increase in the length of the cells), and of a partial disappearance and gradual transformation of these almost undifferentiated cells to the condition in which we find them in the adult.

The former process will be considered first. In the larva in its first instar the imaginal disc of the compound eye is very prominent, forming a definite thick area at each side of the brain; as the larva gradually develops, the cells, as we have seen, divide very extensively; hence the disc becomes larger in area, but the cells, not having increased in size, are in no way any more distinct; indeed, as the ectodermal cells surrounding the developing eye have been increasing in length during this process, the disc is actually less distinct than in the larva in its first instar (fig. 78). So marked has been the disparity in growth between these two parts of the ectoderm that in the large larva, before the optic disc cells begin to grow in size, the disc has undergone a distinct invagination by the partial growth over it of the unmodified head ectoderm. From now on, however, the disc gradually thickens, while the ordinary ectoderm of the head becomes rather thinner. In fig. 77, which is from a larva about sixteen hours before pupation, we see the disc already sharply marked off from the rest of the ectoderm. In fig. 79, which is taken from a pupa thirty-six hours of age, the cells have elongated greatly, and are beginning to turn inwards, towards the optic nerve, as it grows out from the brain. Fig. 80 shows a section of the eye of a pupa which is about ready to emerge. The cells have increased greatly in length, and the bases of the ommatidia converge upon the optic nerve. Meanwhile there has been a gradual increase in the convexity of the eye. (In fig. 78, which is taken from an advanced larva, the eye is shown as very much more convex than in the next stage, taken some ten hours later. There is, however, no real comparison between the two, since the first is from a still actively moving larva, in which the flexible disc must necessarily be subject to considerable distortion.)

The change in direction of the ommatidia probably finds its explanation in the following observation. Beneath the optic disc lies a series of tissues: the mesoderm of the body wall (somatopleure), a membranous ingrowth of ectoderm, as will be described later, and an outgrowth from the brain.(2) These three form a fairly thick mass beneath the optic disc, which later becomes exceedingly firm by the deposition of chitin. Now, as the cells of the eye gradually increase in length they will necessarily be subjected to pressure from these membranes below, and from the cuticle, which they have secreted, above. The cells of the eye, under these circumstances, will be able to retain their straightness for the greater part of their length, which is absolutely essential for them, only by growing in the direction of least pressure, *i.e.*, towards the middle of the disc; hence whereas the cells in the middle can remain vertical, those which are some distance from the middle will have to take up a more oblique position, while those at the circumference of the optic disc, where the cuticle and somatopleure virtually adhere, will necessarily have to take up a horizontal position if they are to develop at all; in short, the degree to which the cells converge will depend upon their distance from the central ommatidium. Under this pressure, of course, not only the somatopleure and its adjacent membranes, but also the cuticle, will bend, and this would account for the increase of convexity of the eye as the cells gradually grew. (The obvious question as to why, under this pressure, the cells might not be expected to converge just as readily towards the exterior as in the opposite direction finds its reply in the fact that the ommatidia are much broader at their distal than their proximal ends; indeed, they are really cone-shaped structures, so that such an arrangement would not be possible.)

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(2) The nature of these membranes will be discussed later.

A short digression may be of interest here. If the above suggestion is correct, it will follow that the convexity of the eye of *Nasonia* depends upon the ratio between the tension of the somatopleure and its adjacent structures and that of the cuticle covering the eye. Insect eyes vary greatly in convexity; one has but to compare the almost spherical eye of a *Cicada* with the rather flat eye of many flies. If it should be of advantage to a species to have an eye of greater or lesser convexity, it follows that it would not be necessary to postulate, in the germ cells, a factor for increased eye convexity, but that the result could be obtained simply either by a strengthening of the germinal representative of the membranes underlying the optic discs, or by a weakening of that of the optic cuticle.

It is necessary now further to consider the histological changes undergone by the developing eye. In transverse sections of the ommatidia the rhabdome cell is seen to be fairly thick, especially at its base, where its nucleus lies. The seven sheath cells can generally be clearly made out, surrounding it (fig. 58c). The pigment cells are long, and extend through the thickness of the disc; the nucleus is in the middle of the cell, although the distal end is still generally the widest part of it. The four vitreous cells have now become fairly distinct; occasionally the lens cells appear to be differentiating, presenting at times a rather vacuolated appearance. They are also seen embracing the outer end of the visual cells more closely.

But it is not till after pupation that any really marked changes appear. In the pupa of about four hours the cells of the developing eye have already increased considerably in length, the thickness of the disc being now 30μ, of which about 25μ represent the length of the sheath cells. The rhabdome cell has meantime narrowed considerably, the proximal end, in fact, having become developed into a rather long narrow filament. The nucleus, which is situated in its lowest portion, is visible only with difficulty. Distally it extends right to the outer surface, where it sometimes projects as a distinct button-like structure. In longitudinal sections of the ommatidium the outlines of the sheath cells are now very difficult, or almost impossible to detect. But if such ommatidia are observed in sections cut transversely to their length, the central rhabdome cell and the seven sheath cells surrounding it can usually be clearly seen (fig. 58d). If the ommatidia are examined in pupae a little older, we find that the number of sheath cells has been reduced to six (fig. 60). Grenacher, working with *Dytiscus marginalis*, and Johansen, using *Vanessa urticae,* could find only six sheath cells. On the other hand, Hesse regarded seven as the normal number for Arthropods; Kirchhoffer found this number in *Dermestes vulpinus.* Günther (1912), using the same material as Grenacher had employed much earlier, found seven sheath cells in *Dytiscus marginalis.* Seven is then, evidently, the number of sheath cells occurring in the early stages of the insect eye.

According to Günther, this number is reduced to six by one of the cells becoming pressed out from among the others. I believe the same thing occurs in *Nasonia* in the early pupal period, but the structures dealt with are so exceedingly minute in this insect, that accurate observations on this point are very difficult. I am also unable to describe the ultimate fate of the seventh cell that has been cast out, whether it disintegrates, or whether the other sheath cells develop at its expense, or, finally, whether leucocytes absorb it.

The four vitreous cells are rather distinct, and the developing lens cells are continuing to apply themselves more closely to the distal end of the ommatidium. The six pigment cells have become very narrow, their nuclei remaining in a position considerably above their middle; at times the pigment cells have still a distinctly spindle-like appearance.

The visible changes that take place during the next twelve hours are not very pronounced; the filament-like process at the proximal end of the rhabdome cell becomes more marked; at the periphery of the optic disc it undergoes an extraordinary elongation, becoming about two-thirds as long as the rest of the ommaditium *(cf.* fig. 79). The distal end of the cell projects quite distinctly beyond the vitreous and lens cells (fig. 61); it is possible, however, that the appearance of this structure in preparations is due to the action of reagents used in making them. The vitreous cells have become quite distinct, and the two lens cells have embraced them still more closely. Their protoplasm has become slightly granular, while the nucleus is very large, with scattered chromatin and a very distinct though small nucleolus, and lies in the lower part of the cell. The four pigment cells (3) surrounding the ommatidium have altered in shape; they appear now as rather thin filaments, with a great swelling at a distance of about one-third their length from the anterior end, a swelling which lodges the nucleus (fig. 59). The latter is rather distinct; its chromatin is scattered, and it contains a small but very distinct nucleolus

From now onwards the visible changes become more pronounced The rhabdome and sheath cells continue to grow in length, reaching in the twenty-one hour pupa a length of about 38μ, the total thickness of the eye at this stage being 48μ The four vitreous cells have increased in size, and now quite surround the end of the rhabdome cell except at its termination, where it can still often be seen projecting beyond them (fig. 61). Their cytoplasm is fairly clear, and they possess each a relatively very large, rather irregular nucleus. The two lens cells, which have been gradually approaching the vitreous cells from the sides, now wholly surround them above and at the sides, embracing them closely (fig. 62). The nuclei are lodged in their lower portion; each possesses a very distinct nucleolus. The rhabdome cell has meanwhile been narrowing for the greater part of its length, but it is even yet visible, though only very faintly, amongst the vitreous cells. At this stage the sheath cells which have extended by very delicate processes, over the proximal filament of the rhabdome cell, begin to develop granules of a reddish-brown pigment throughout their length, so that in this insect the capacity of forming pigment is not confined to the true pigment cells (fig. 63). The latter, indeed, at this stage are still quite devoid of granules. Other changes, however, which may be the forerunners of pigment formation, are now going on in them, and they now assume a very remarkable form; the cells which were, before this, filamentous, or at times spindle-shaped, become even narrower, except in their distal third, which remains rather thick (fig. 62); their protoplasm becomes vacuolated, the vacuoles at times producing small swellings in the thread-like filament. It is towards the proximal (inner) end of the cell, however, that this process has its most remarkable result. Here, at a short distance from the end, a relatively huge vacuole is formed which causes this part to swell up in a large globule. This condition is very characteristic of the pigment cells at this stage. During the next two days the globule remains, and, if anything, grows even more distinct (figs. 59, 61, 62, 73). The nuclei do not change their position; their nucleoli, at times, become relatively gigantic.

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(3) At first sight, there appear to be six pigment cells surrounding each ommatidium. Each pigment cell, however, becomes applied to *two* ommatidia; hence of the six which are observed around each ommatidium, two "belong" to adjacent ommatidia This will become clearer by examining fig. 64d

From now onwards the cells do not increase much more in length, the eye reaching (exclusive of the lens) a thickness of about 50μ in the adult wasp. The most clearly visible changes during this period that occur in the cells are those connected with the deposition of pigment in the pigment cells. This takes place during the third day of pupal life. The slender filamentous pigment cells become highly vacuolated; indeed in many, at this stage, the vacuoles occupy so great a space and have adhered to such an extent, that practically all the cytoplasm of the cell lies at the periphery (fig. 73). It has also been seen that whereas the greater part of the pigment cell is in the form of a filament, there is a very characteristic globular swelling a short distance from its proximal end, while the distal third remains thick. The nucleus now moves upwards a little, and lodges in the distal thickening, so as to lie close beside the lower portion of the adjacent lens cell. At the same time the distal end spreads out and embraces portion of the lens cell nearest to it (fig. 64). The pigment cells thus co-operate in forming a complete coat round the vitreous and lens cells. The cells now begin to undergo pigmentation. The distal fifth, on account of its thickness, forms a heavy mass of "iris-pigment," evidently rendering the vitreous and lens cells optically isolated from one another (fig. 64d). This isolation is increased by heavy pigmentation of the lens cells in the pupa of three and a half days. In the proximal third of the cell pigmentation is fairly heavy (fig. 64b), but much less so than in the distal portion. The region of the pigment cell intervening between these two parts presents only a single row of reddish-brown granules, enclosed in a very delicate sheath—the cell membrane. The increased formation of pigment in the proximal portion of the cell must be connected directly with the globule which forms here, and which, in the late pupa, has quite disappeared. We thus recognize three differently pigmented layers in the eye of *Nasonia;* an outer heavily developed "iris" pigment layer, an intermediate weakly pigmented layer, by far the thickest of the three, and a rather small, fairly heavily pigmented lower layer (fig. 80). The granules are exceedingly minute, and vary in shape from spherical to almost cylindrical.

Meanwhile the sheath and rhabdome cells have continued their development. Transverse sections of the eye show numerous ommatidia cut across. Each of these is seen to consist of the central rhabdome cell, surrounded by six sheath cells all embedded, it appears, in a gelatinous(?) matrix. In almost mature pupae the rhabdome cell appears as a brownish rod, workers with larger insects seem to agree that this consists of chitin, and the appearance of the rod in *Nasonia*, with its sharply defined outline, certainly lends support to this view. The rod has evidently been secreted directly from the rhabdome cell. (This view has, of course, been assumed throughout in applying the name to that cell(4).) It can be seen entering the distal cell complex, but, as far as I could observe, does not reach to the exterior.

The development of the lens cells has already been described. The development of the vitreous cells which they enclose is completed at about this time. This consists in a curious movement of their nuclei upwards to lie very close below the chitinous lens, and the four cells arrange themselves in such a way that an opposite pair is in contact for a considerable distance, so that the remaining two do not meet each other (fig. 64c), but so far as I could observe, the rhabdome no longer extends right through this distal cell group.

Meanwhile the cells have not lost their property of secreting cuticle. During larval life the outer layer of cells of the optic imaginal disc, from which the pigment cells, vitreous cells, and lens cells later develop, secrete the larval cuticle (fig. 55), while towards the end of larval life they secrete the cuticle of the pupa. But when once this cuticle has been secreted, the cells commence to differentiate into pigment cells, vitreous cells, and lens cells, and it is in the last alone that this property of cuticle secretion is retained. Already in the pupa of twenty-one hours, at a time, namely, when the lens cells have scarcely surrounded the vitreous cells, an outwardly convex cuticle is being secreted by each ommatidium. Since the rhabdome cell at this stage forms part of the external boundary of the ectoderm, it seems difficult to deny that it plays a part in this process. Indeed, since the rhabdome cell secretes a *chitinous* rhabdome over the greater part of its length there is no apparent reason why the distal part, included among the vitreous cells, should lose this property. If we grant that this portion of the cell assists the lens cells in the early stages of lens formation, we might have a suitable explanation for the otherwise unexplained disappearance of the rhabdome cell from the end of this cell complex. But the chief agents in the formation of the lens are the lens cells, which gradually transform the rather thin concave-convex cuticle of the early pupa into the thick biconvex mass as we see it in the late pupa and adult (fig. 64).

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(4) The sheath cells are usually regarded as aiding in the secretion of the rhabdomes. I could, however, find no evidence for this in *Nasonia*.

By this remarkable series of changes, the originally three-layered condition of the imaginal disc of the first larval instar, which has itself doubtless been produced from a previously single-layered ectoderm, gradually transforms itself into the wonderfully specialized state in which we see it in the adult—a state in which it does not depart essentially from the three-layered condition, and in which the function of secreting cuticle is retained, though modified, in such a way as to aid it in performing its new function.

A feature of the compound eye of *Nasoma* is the entire absence of tracheae between the ommatidia, structures which are so prominent in the eye of *Calliphora* (Lowne, Hickson).

The description of the compound eye has been confined, so far, to a consideration of the development and differentiation of the simple optic disc of the newly hatched larva. But immediately below the eye there is formed during the late larval and pupal life an important structure whose function it is to support the nervous elements of the eye. This structure is developed directly from the ectoderm surrounding the optic imaginal disc, and it will be necessary to describe its development here; it will also be convenient, though not perhaps strictly logical, to give an account at this stage of the development of the innervation of the compound eye, since these two processes are intimately connected with one another.

An examination of a medium-sized larva shows that immediately below the ectoderm there is a delicate membrane with distinct nuclear swellings, the mesodermal somatopleure; it is clearly visible below the optic disc, and no other tissues underlie it. But when the larva is about to defaecate it is seen that two areas of proliferation have arisen in the head ectoderm above and below, and in close contact with the optic disc. From these areas the proliferating ectodermal cells grow towards each other, and finally meet, forming a very prominent bridge across the back of the imaginal optic disc. The cells soon spread out laterally, and form a membrane completely covering the back of the developing eye (figs. 77, 78). Internal to this disc, of course, the somatopleure must lie. In the larva which is about to pupate the membrane has extended completely behind the eye. When the membrane is examined at this stage a very remarkable thing is seen. The cells stand off a considerable distance from the adjacent optic disc, so that a very distinct basement membrane can now be seen underlying it. This membrane connects the internal ends of adjacent pigment cells, from which it has doubtless been secreted. These pigment cells surround the ommatidia fairly closely, but are not in direct contact with them, and they secrete the basement membrane in such a way that a hole is left at the base of each ommatidium, thus permitting the easy entrance of a nerve towards the rhabdome cell. This basement membrane is the fenestrate membrane of the eye, and will be referred to as such hereafter. It undergoes scarcely any visible change during the rest of larval and pupal life.

The cells of the inflected ectodermal layer (which may, for convenience, be spoken of as the *perioptic membrane*, to show its relation to Hickson's Periopticon) now undergo a remarkable process of branching (fig. 74), the branches being of three types: (1) those which unite the cells with similar processes from other cells of this layer, (2) those which connect the cells with the fenestrate membrane, and (3) those which grow in towards the brain.

The cells themselves are large, with a distinct but irregular nucleus; the branches which connect neighbouring cells together are not very numerous. The second type of process is very remarkable, and is seen to join up, each, with the base of a group of pigment cells, and several such processes may be seen coming from a single cell of the perioptic layer. Since these processes thus fuse in reality with the circumferences of the holes in the fenestrate membrane at the bases of the rhabdomes it would seem probable that they are hollow; later events show that this must be so. The third type of branching is also very remarkable; this consists essentially of a great massive outgrowth of fibres towards the adjacent cortex of the brain. This great fibrillar mass from the inner side of the cells of the perioptic layer now enters the more ventral portion of the brain (having apparently broken away its own somatopleure and the splanchnopleure of the brain) and gradually terminates amongst the cortical cells comprising it. At the same time these cortical cells become active, and, dividing mitotically, begin to proliferate and to migrate outwards in the meshwork of fibrillae, towards the optic disc.

The function of the perioptic membrane is thus to form a kind of neuroglia to support the nerve cells of the optic ganglion; but it seems to have a second function, namely, to act as what must essentially be regarded as a neurolemma. From the above description it follows that no nerve fibre can penetrate to the rhabdomes unless it can enter the cavity of the processes which are attached to the fenestrate membrane. I was unable to observe how the nerve fibre penetrates to this portion, *i.e.*, whether it forces its way through the cytoplasm of the cells of the perioptic layer, or whether, entangled as it is in the fibrillae of the cells, it works its way just below the cell membrane, and passing round to the opposite side, enters the process to the fenestrate membrane. It is certain, however, that a fibre from a nerve cell does eventually work its way into one of these processes. This is clearly shown in fig. 74, where the nerve cell gives off a long fibre which communicates with the ommatidium, and is entirely enveloped by the cell process which meets the fenestrate membrane. The cells of the perioptic membrane must, therefore, be regarded as functioning, also as neurolemmae. Moreover, it follows that, as a single cell gives off processes towards a number of ommatidia, a single perioptic cell must act as neurolemma for a number of distinct nerve fibres. I have not been able to see distinct instances of this in my preparations, partly because, in pupae a little older, when this process has been completed, the cells of the perioptic membrane have cohered closely together, making further observations on this point impossible; but the fact that all the ommatidia, several of which were supplied with processes from a single perioptic cell, later have nerves entering them, leaves us no alternative but to accept this view (compare, however, fig. 75). The nerve cells which have entered the perioptic membrane can often be seen to give off a distinct process backwards towards the brain; but I was quite unable to trace any of these fibres to their termination.

The coherence of the cells of the perioptic membrane, which takes place in pupae a few hours later, gives the structure a much firmer appearance, the loose branching network of the pupating larva being transformed into a fairly thick pavement membrane. At this stage leucocytes are occasionally seen between the perioptic membrane and the optic disc. What their function is I am not able to say.

When pupae about twenty-four hours old are examined, a further development of the perioptic membrane is seen to have taken place. The "neurolemmal" processes are no longer visible; probably the best interpretation which can be placed on this is that their disappearance is only apparent, and that they have now assumed their true function as neurolemmae and have closely enveloped their respective nerve fibres (fig. 75). These fibres can be seen communicating with every ommatidium, but they are so exceedingly minute that the non-appearance of a neurolemma as distinct from the nerve is only to be expected. I am also unable to say where the nerve ends and where the ommatidium starts; and whether the nerve terminates on a rhabdome or on the sheath cells. The fact, however, that the latter have undergone pigment degeneration, and the close resemblance of the sensory cells of the ocelli (which are innervated) to the rhabdome cell, seem to indicate that it is in the rhabdome of the ommatidium that the nerves terminate.

At this stage the fenestrate membrane shows a curious appearance which may easily be misinterpreted; the ends of the pigment cells which have secreted it become dilated into small cones, and give the membrane the appearance of cellular tissue; in reality, however, it is entirely non-cellular (*cf.* fig. 62).

The development of the great mass of fibrillae from the side of the perioptic membrane towards the brain, as above described, is confined to the middle third of that membrane; consequently the complete optic "nerve" never occupies an area greater than this. In the thirty-six hour pupa the fibrillae have become so massed together as to form a thick layer of fibres running longitudinally to and beneath the disc, the individuals of which are no longer visible These, then, pass down the optic nerve and enter the brain

In the pupa of the third-day pigment granules begin to form in the optic "nerve," and become very prominent a day later. Changes are now taking place which involve the ommatidia as well; these consist of a gradual alteration of the shape of these structures. In the pupa at about the end of the third day that portion of the perioptic membrane which has not been concerned in the formation of the optic nerve begins to undergo chitinisation, and since this membrane was produced from, and still is continuous with, the ectoderm immediately surrounding the eye, it follows that this chitin layer will be similarly continuous with the chitin which now begins to form on the head of the wasp; this chitinisation of the back of the eye appears to push the nervous part of the optic "nerve" out of position, by pressing on its periphery; at any rate, it now assumes an outwardly convex form. This effect is really produced by a "shear-like" action of the chitinising perioptic membrane, the lower portion pressing outwards and upwards, the upper down and inwards. This process is complete in the four and a half-day pupa (fig. 80). The "optic nerve" from the brain at this stage has also assumed the appearance of a solid projection from the lower side of the brain in its more ventral portion and is crowded with nerve cells; the detection, however, of individual nerve fibres in this region is quite impossible owing to the close coherence of these.

This shear-like action of the chitinising perioptic membrane results also in a curious change in the shape of the ommatidia, which is very easy to recognize (in spite of their very close clustering together in this region), on account of the rows of red pigment granules which run along them (pigment of the sheath cells). The lower ommatidia, which were originally straight, now become bent, and, as the passing inwards and upwards of the perioptic membrane increases, become bent more and more, and eventually come to curve back upon themselves, in order to maintain connection with the optic nerve. This recurving is exceedingly characteristic of the lower ommatidia of the eye; from the above description it necessarily follows that the higher the ommatidia are in the eye, the less will they be bent; in the upper ones, indeed, the bending has been only very slight (fig. 80).

The outstanding feature, then, of the development of the eye during the last day and a half of pupal life is the bending outwards and compression of the optic "nerve," and the consequent curving of the ommatidia, movements which are probably to be explained as due to the compressing action of the perioptic membrane, as it begins to chitinise.

By this complex process there is gradually produced the eye as we see it in the adult wasp, with its corneal lenses, pigment layers, and ommatidia resting upon the fenestrate membrane, which admits the fibres from the optic "nerve," and in intimate relation with which has been produced a disc of chitin which protects the eye from within, and the whole organ covered internally by a very feeble membrane—the mesodermal somatopleure.

It is necessary to refer now to the work of others on the development of the eye. It is in Weismann's great memoir (1864) that we find the first correct account of the development in its main outline. He regarded the layer of lenses and ommatidia as arising directly from the surface ectoderm, while the optic ganglion ("bulbus") he regarded as being a direct outgrowth from the brain. He apparently even saw the perioptic membrane, of which he says: "Between the bulbus and the disc there penetrates a thin layer of fat and granule cells, from which the cells which unite the two surfaces very probably develop." He summarises his description thus: "The morphological value of the different parts of the eye is as follows: the cornea is the chitinous skeleton; the other parts of the eye-chamber (the crystalline cones, nerve rods, and their investments) are modified hypodermis; all the central structures (the ganglion layers and bulbus) are formed as outgrowths from the nervous system" (quote from Lowne).

If the perioptic membrane in *Nasonia* and the blow-fly are of similar origin, then Weismann's view as to its origin is incorrect; his very recognition of the membrane, however, in *hand dissections* of fly pupae is itself a remarkable instance of his power of observation. His descriptions are supported by the work of G. H. Parker (1890) and of Carrière (1884). Later workers, using much more accurate methods, have contradicted Weismann's statements; their descriptions, unless the process is different in the material which they used from what we see in *Nasonia*, are, however, quite erroneous.

A number of writers, *e.g.*, Reichenbach (1886) or Patten (1886), regard the Arthropod eye as having arisen as an invagination of the ectoderm, with subsequent fusion of the rim of the depression. The upper and lower layers of the invagination then meet and produce, between them, the vitreous and lens cells and ommatidia. According to Reichenbach (working with the crayfish), two other layers are formed between these two. The superficial and outer of these two layers then fuse and produce the layer of vitreous and lens cells; the third layer forms the rhabdomes, and the inner layer is actually regarded as forming the ganglion.

Patten (1886), on the other hand, regards the superficial layer as forming the cornea; the outer layer of the flattened vesicle disappears, and the rest of the invagination forms the ommatidia. The more recent work of Günther (1912) on *Dytiscus marginalis* supports Weismann's original account.

Lowne (1893-1895) partly accepts Weismann's views, but disagrees with him in certain important points, in which, however, he is undoubtedly incorrect. In support of his Dioptron Theory of Insect Vision he wholly denies the penetration of the fenestrate membrane by nerves; but there can be no doubt as to its occurrence in *Nasonia*. His view of the origin of the rhabdomes is very remarkable; he regards these structures as arising from the mesoderm and developing in a manner analogous to that of the tracheae of the eye (these are highly developed in the blow-fly); the perioptic membrane he regards as growing out from the brain, although the occurrence of so much neuroglia tissue in that organ has not been demonstrated. An examination of fig. 71 (p. 546) of his work shows the perioptic membrane communicating with the ectoderm on either side of the optic disc; the cells stand off from the fenestrate membrane, and nerve cells are seen migrating into the fibres of the optic stalk, which may possibly have been formed from the cells of the perioptic membrane. In fig. 6, pl. xxxviii. (p. 548), he actually shows a branching cell of the perioptic membrane attaching itself to the fenestrate membrane at the base of the ommatidia, exactly as I have described it above in *Nasonia*. There seems, then, to be little doubt that the origin of this membrane in *Calliphora* is identical with what happens in this wasp.

The Ocelli.—The development of these structures can be followed from the earliest larvae right throughout larval and pupal life to the mature condition of the adult wasp. This is rendered possible by the fact that around those three small areas of the head ectoderm from which the ocelli will later develop the somatopleure of the head is deflected downwards (fig. 66) and becomes continuous with the splanchnopleure covering the brain, these curious structures are doubtless the remnants of what must once have been a very extensive connection between the ectoderm and the nerve cord as it sank inwards in the embryo. From this fortunate occurrence, it is possible to trace the development of the complex ocellus from a stage in which it is represented by a single pair of minute cells (fig. 66), a condition in which we see it in the larva of the first instar.

The ectodermal cells covering the head at this stage are small in number though rather large and irregular; two cells, however, included in each area covered by the conical deflected somatopleure are considerably smaller than these. During larval life these cells undergo division, so that in the larva which is about to defaecate, one sees a conical mass of about a dozen cells, rather slender and elongated, in the place which in the early larva was occupied by only two (fig 77).

These cells continue to multiply mitotically, so that in the freshly formed pupa the ocelli are represented each by a rounded thickening of the ectoderm in which the cells are beginning to arrange themselves in concentric layers, at the same time increasing somewhat in length (fig. 67). During the next four hours there is an active proliferation and elongation of these cells, giving the whole structure an appearance very like that of a mammalian taste bud. The cells are elongated and spindle-shaped, and present each a short process externally. These cells become the visual cells of the ocellus, and their short processes, which together form a small group at the extremity of the sense organ, project freely from it.

Meanwhile the head ectoderm surrounding the ocelli proliferates and begins to encroach upon the area which has till now been occupied by the ocellar cells. In the twelve-hour pupa (fig. 68) this can be seen to result in a gradual constriction of the upper end of the ocellus, which at the same time begins to be forced down below the surface.

In the thirty-six hour pupa this process is complete; the ectoderm has grown right across the ocellus, and in its middle is seen to undergo a distinct lens-like swelling (fig. 69).

This growth inwards of the ectoderm surrounding the ocelli not only results in a sinking downwards of the ocellus, but it also brings about an almost total closure of the cup, and the cells which now comprise the ocellus are of two kinds, the upper ones forming the "rim" and the "lid" of the cup are small and cubical, they will develop later into the sides and part of the "iris" of the ocellus. The others are the developing visual cells; those in the lower part of the ocellus sink downwards a little, the combined result of these processes being to form a cavity in the upper part of the ocellus, into which the visual cells project. These cells have meanwhile become distinctly conical by the broadening out of their bases, and their inner ends are beginning to turn towards the "pupil" of the ocellus, *i.e.*, to the space resulting from the incomplete closure of the distal portion. The nuclei are situated towards the base of these cone-shaped cells. At this stage also the distal terminations of the visual cells are beginning to constrict considerably more, *i.e.*, the visual rods have commenced to develop.

Meanwhile the cells of the ectoderm covering the ocellus become irregular. Their nuclei move into their basal portions, and the distal ends begin to secrete an outwardly convex cuticle. This is the beginning of the ocellar lens (figs. 69, 70).

The cells now continue to grow in size, especially the visual cells, which become rather long and robust, with large prominent nuclei in their basal portions. In the pupa of the third day the visual rods are completely developed; each has apparently been produced by a constriction of the distal portion of the visual cell. These cells also begin to undergo pigmentation at this stage, the pigment granules being confined to the distal portion of the cell, immediately adjacent to the visual rod.

The most obvious features of the development of the visual cells at this stage is their marked increase in length, which now results in a considerable lengthening of the whole ocellus; this also appears to bring about a slight downward movement of the ocellus as a whole, resulting in the cubical cells of the distal end assuming a more peripheral position. Meanwhile the superficial ectodermal cells continue to secrete the lens, which has in the three-day pupa become distinctly biconvex (fig. 70). The nuclei of these cells retain their position at the base of the respective cells, while the distal end appears to undergo a fibrous degeneration, a change evidently connected with the development of the lens; so far as I could observe, the basal portions of these cells do not disappear, but aid the cubical cells in the distal part of the ocellus to form the "iris" (fig. 70).

In the four and a half-day pupa these changes are complete. The lens is strongly developed, biconvex, with the greater convexity turned inwards; pigmentation has increased, and the iris is so disposed as to leave a rather large "pupil" space, towards which the visual rods all point (fig. 71). An isolated adult visual cell is seen in fig 72. It measures about 24μ in length, of which $10{\cdot}4\mu$ is occupied by the visual rod.

This description holds for the median as well as the lateral ocelli; a transverse section of the former, however, shows that it is strongly indented in its anterior wall. It is essentially a double ocellus; and its double nature can be recognized throughout development. As is to be expected, its nerve communicates with *two* ocellar ganglia.

During this process the mesodermic somatopleure lining the base of the ocellus has grown considerably, and occasionally is very prominent. It is retained throughout pupal life and is seen in the newly hatched wasp as a distinct membrane, with fairly prominent nuclei, close to the ocellar wall.

The innervation of the ocellus is quite different from that of the compound eye. In the late larval stages, after defaecation has taken place, nerve fibres grow out from the brain, towards the ocelli, guided apparently by the deflected somatopleure. In the newly formed pupa the nerve has already come into contact with the developing visual cells of the ocellus, and the only visible change undergone by the nerve as development advances is an increase in size; in the early pupa it is long and slender, but as the ocellus is forced below the surface of the head, and as the brain increases in size, the nerve becomes shorter and thicker. It is not necessary to describe the formation of the ocellar nerves more fully at this stage beyond mentioning that the ocellar nerve is a true nerve, *i.e.*, quite devoid of cortical brain cells, and therefore quite different in nature from the optic "nerve," which is essentially an outgrowth of the brain cortex.

C.—THE RESPIRATORY SYSTEM.

The Larval Organs.

In the newly hatched larva (fig. 1) there is a pair of great longitudinal tracheal trunks passing from the second segment backwards on either side of the body to the twelfth segment; these are connected with one another, in front and behind, by two transverse tracheal vessels, of which the anterior passes over the oesophagus, the posterior under the rectum. The anterior transverse vessel shows a small, forwardly projecting median part, evidently indicating the point of fusion of the tracheal trunks as they grew inwards, towards each other, in the embryo.

The longitudinal vessels open to the exterior by four pairs of spiracles; one on the third segment, a second on the fifth, the next on the sixth, and the last on the seventh segment, each connected by a rather short stigmatic trunk to the great longitudinal vessels of the larva. The tracheal vessels in the region of the fourth, and the eighth to the eleventh segments, are provided in each segment with a pair of small rudimentary trunks, which are related to certain spiracles which do not develop till the next larval moult; there are, therefore, nine pairs of spiracles functioning either throughout larval life, or only in the later larval instars.

Besides these nine spiracles there is a pair of tenth rudimentary stigmatic trunks, situated in the twelfth segment. They do not open on to the surface till at the time of the last larval moult, and become the posterior spiracles of the abdomen of the imago. Of the ten potential stigmatic trunks only nine, therefore, function at some time or other during larval life. It is interesting to notice that the larva of the honey-bee develops the full set of ten spiracles.

In each segment the tracheal trunks give off a number of thinner branching vessels, which on account of their different structure I shall speak of as tracheoles They are clearly seen (figs. 1, 2) in living larvae as fine silvery lines ramifying among the organs of the larva; generally there are two or three pairs in each segment which pass vertically, as well as, especially in the more posterior segments, several pairs which run dorsally, but are usually more difficult to see. The anterior transverse vessel supplies the head by means of two groups of tracheoles, which run forwards, but are not, at this early stage, very strongly developed From the posterior transverse vessel several small branches are given off to the anal segments.

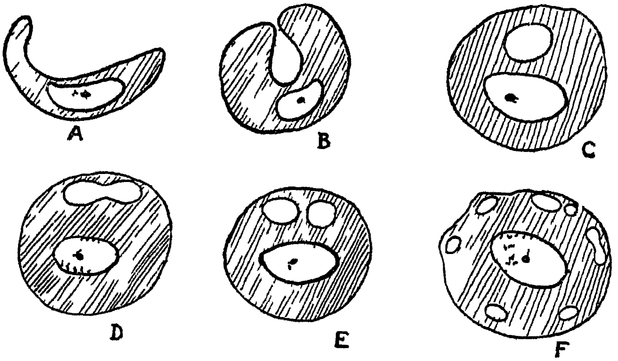
Structurally there is a very pronounced difference between the great longitudinal and transverse tracheal trunks and the stigmatic trunks, on the one hand, and the smaller branching tracheoles on the other.

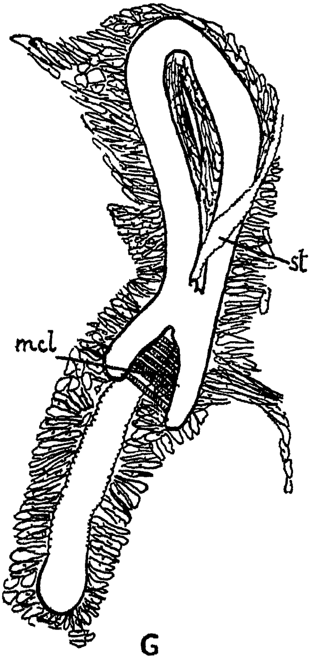
In very young larvae the true tracheae are tubes with an epithelium of rather thick cubical clear cells, which have already secreted the "spiral" intima; before the end of the first instar these cells have become slightly granular, and the general growth of the larva is accompanied by a gradual flattening out of these cells. The stigmatic trunks are similar in structure (fig. 93); the spiracles are small cup-like structures, lined by an intima devoid of "spirals." Their intima is shed, and a new one reformed at each moult.

The tracheoles are structurally quite different (figs. 76, 81); each group or branching system of tracheoles is essentially a unicellular structure, of remarkable dimensions. It consists of a large clear tube, which soon branches into two; from these branches numerous smaller trunks come off, and these ramify amongst the organs of the larva. The tubes are entirely devoid of a chitinous intima, spiral or plain, and never, so far as I could observe, terminate *within* the cells of any tissue. The nuclei are oval, and very large, measuring at the end of the first instar 21μ in length, 8μ in breadth; nucleoli are absent, the chromatin is scattered throughout the nuclear space, but two karyosomes are generally present (fig. 10). The nucleus is usually situated at, or a little beyond, the first point of branching.

The tracheoles of the imago, which will be referred to later, differ somewhat from these larval tracheoles; nevertheless, there is a close similarity between the two, and the development of the latter may be inferred from what is observed to occur in the development of the former.

There they are formed invariably as outgrowths from the tracheal trunks, and there can be no doubt that it is by this method that the larval tracheoles are formed during embryonic life. They are to be looked upon as modified tracheal epithelium cells, which grew in size and developed into cells to which the name *Giant Tracheoloblasts* may be applied. These cells then began, still during embryonic life, to grow out from the tracheae and developed the tracheoles from themselves, as they grew out. It is difficult to determine exactly how this happened; probably the great tracheoloblast which already enclosed, on account of its size, a considerable portion of the lumen of the trachea, began to grow outwards at one end. As it grew outwards its two free edges fused together, forming a tube. A tracheoloblast in this condition leaving the renovated longitudinal vessels and growing outwards to form a tracheole of the imago is shown in fig. 82. The cell with its great nucleus then grew further and further out, secreting the main branch of the system after it, as it advanced. Soon, however, the nucleus ceased to advance, perhaps on account of the pressure of the fat body, which occupies so much of the haemocoele, and the ramification of the tubes began by a different method; protoplasmic outgrowths were produced from the termination of the tracheoloblast, probably by the frequent division, within the main substance of the cell, of its lumen. The probable method of branch formation within the main portion of the tracheoloblast is shown diagrammatically in text figures A-F. Several pairs of these systems of tracheoles occur in a single segment,





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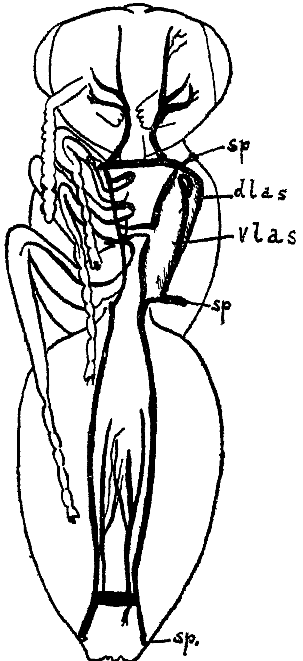

H

Text figs A-F Diagram of the Giant Tracheoloblast in transverse section, showing successive stages in the formation of tracheoles

Text fig G Developing spiracle of propodeum from the larva shortly before pupation Note the great "clip," through which passes the lumen of the air tube (st) Closing of the clip is brought about by relaxation of the muscles (mcl)

Text fig H Diagram of respiratory system of adult wasp sp, spiracle, d l a s, dorso-lateral air sac, v l a s, ventro-lateral air sac and the co-operation of these must produce a very efficient respiratory system for so sluggish a larva.

So far as I am aware, no respiratory vessels similar to those here described have been observed in other insects. The complexity of shape of these great branching cells (fig 76), indeed, finds no parallel, except amongst the nerve cells of higher animals. In some ways, indeed, they closely resemble these; and their method of extension is very similar to that observed by Ross Harrison in his well-known work on the growth of embryonic nerve fibres in plasma media, while as an example of a Trophospongial cell, in the sense in which Holmgren employs it, they are quite unrivalled.

In the majority of insects the smaller air tubes are true multicellular tracheae, the terminal portion of which alone is devoid of spirals and is evidently intracellular, it would seem, then, that the great unicellular tracheoles above described are homologous with the terminal portion of the tracheoles of other insects. Indeed, Pérez (1910, p. 191) gives an account of the development in *Calliphora* of the terminations of the tracheoles among the muscles of flight, which is not unlike the process by which the large tracheoles of *Nasonia* are developed. From this it would seem to follow that the dorsolateral air-sacs of the adult *Nasonia*, as well as some of the great head and abdominal vessels which develop during pupal life (see below) are homologous with the general system of smaller tracheal vessels occurring in other insects

The main change which the tracheal system undergoes in the first instar is a slight increase in the complexity of the tracheoles; towards the end of this period those stigmatic trunks which have not yet opened on to the surface (the fourth, and the eighth to the eleventh) grow outwards, and at the next moult begin to function.

The tracheal system has now attained to its mature condition, and during the rest of larval life is characterized mainly by a considerable increase in size and the extent of its ramification, as the larva itself grows. Especially marked is this tracheal proliferation in the head region, where the brain is developing. The increase in complexity of the respiratory system is shown by comparing figs. 1 and 2, and is due entirely, so far as I could observe, to an increase in the size and complexity of the great branching cells, not to a formation of new ones.

The extensive branching of the tracheoles makes it impossible to measure the size of these, but that the increase in bulk is very large is unquestionable. The nuclei of the tracheoles show only a slight increase in size. Thus, while the nucleus of the tracheoloblast measured 21μ by 8μ at the end of the first instar, at the end of the last it measured 24μ by 9μ.

Within the main tracheae the growth of cell and nuclear size is more easy to estimate. Throughout larval life the cells become gradually more granular in appearance, and at the end of larval life appear as large flat discs upon the surface of the tracheal intima, which has itself stretched considerably. The nuclei have become greatly hypertrophied; their chromatin has become scattered through the nucleus, the karyosomes having disappeared, in their place is found a great nucleolus (figs. 84, 85, 86, 87, 92).

At the end of the first instar the cells of the tracheal epithelium measured, on the average, 14μ in length, considerably less in breadth. In the adult larva they measured about 34μ in greatest length, 10 to 11μ in breadth. So far as I could observe, this great hypertrophy of the nucleus is not accompanied by a corresponding increase in the quantity of chromatic material; the nucleus extends not in the volume of its contents, but by a loosening of its texture. The respiratory system of the mature larva, like the other purely larval organs, is to be looked upon merely as a greatly hypertrophied condition of the tracheal system of the newly formed larva; no differentiation of essentially new structures ever occurs.

Having remained in this condition for about a day (resting period of the larva), the tracheal system begins, at the time of defaecation and in the post-defaecation period, to disintegrate, and by the time the pupa has been formed (one day later), only a few disintegrating vestiges of the old tracheal system are recognizable.

The Destruction of the Larval Tracheal System.

The processes of disintegration of the old larval respiratory system and the regeneration of the system of the adult are contemporary; indeed, the imaginal cells often push the worn-out larval cells aside, before the leucocytes have had time to remove them. Nevertheless, it will be better to consider the two processes separately.

The epithelium of the main tracheal vessels begins to disintegrate, at the time of defaecation, and in eight hours' time has wholly disappeared. Besides the presence of the great nucleolus, and a general hypertrophied condition of the cells, these show no abnormal characteristics. Occasionally, however, distinct vacuolation of the cytoplasm can be observed.

At the time of defaecation, however, these cells begin to suffer attack from leucocytes; this is especially well seen in the main longitudinal vessels at about the time of defaecation (figs. 83, 86). The actual process of histolysis is difficult to observe on account of the smallness of the objects dealt with; but that the leucocytes play a large part in the removal of the tracheal epithelium is clear. The tracheal intima does not suffer any corresponding change.

The destruction of those lateral stigmatic trunks which do not persist in the adult wasp begins in the freshly formed pupa. Here the cells lining the lateral stigmatic trunks undergo cytoplasmic degeneration. This stage is easily recognized on account of the great hypertrophy of the nucleoli, a condition so characteristic of the worn-out larval cells of *Nasonia.* In close connection with the disintegrating stigmatic trunks leucocytes may occasionally be seen, actively removing the *débris.* Whether the remains of the cells (nucleus and cell wall) disintegrate of their own accord, or whether leucocytes remove them, I am not definitely able to say; the appearance of preparations rather suggested the latter.

Composing the epithelium of the stigmatic trunks are two kinds of cells. There are large, purely larval cells, and much smaller imaginal cells; it is only the former that grow during larval life, and degenerate at the end of it. The imaginal cells are clearly seen in even the youngest larvae at the bases of the trunks (fig. 93). It is from these "imaginal nests" that the whole tracheal system of the imago becomes formed. (See below.)

The whole process of disintegration of lateral spiracles occurs in the early stages of pupal life, much later, therefore, than that of the tracheae; the stigmatic trunks which disappear in this manner are the second, the third, and the fifth to ninth, only the stigmata of the pronotum and propodeum, and the newly formed pair of the twelfth segment (see below) being retained.

The whole system of tracheoles also disappears; in the living insect, however, in which the tracheoles are clearly seen through the transparent cuticle, no discontinuity in the general structure of the respiratory system is apparent. This is due to the fact that the new tracheal system is forming as the old degenerates (*cf.* figs. 88, 91). In the sixteen-hour pupa the tracheoles still appear quite normal, though greatly hypertrophied. But shortly after this leucocytes begin to accumulate round the finer tracheoles of the head cavity and the process of histolysis commences. Sometimes the leucocytes may be observed forsaking their free life in the blood-stream; attaching themselves to a branching system of tracheoles they begin to crawl over these, and eventually phagocytosis commences (figs. 88, 90, 91). By the time the larva pupates (six to eight hours later) the finer tracheoles of the head have disappeared, and the larger ones are rapidly undergoing the same fate.

Many of the tracheoles, however, appear to undergo mainly chemical disintegration; lying, as they often do, closely embraced by the great "fat cells," they seem to be protected from the action of the leucocytes. Their protoplasm becomes finely vacuolated, the lumen disappears, and the tubes gradually fragment. This is especially beautifully seen in some of the great head tracheoles, which disappear at about the time of pupation (fig. 91). The great abdominal tracheoles disappear a few hours earlier, also by chemical disintegration; frequently, however, if the pupating larvae are examined, rows of leucocytes in the place where the larval tracheoles once were, indicate that phagocytosis of the vestiges of the tracheoles has, in the end, occurred. Active phagocytosis may be observed at times, however (figs. 87, 88), in places, such as, for instance, the cavity of the thorax, where they are easily accessible to the wandering phagocytes. Several phagocytes may apply themselves to the degenerated tracheole, and, dissolving parts out of it, gradually absorb it.

Thus, partly by chemical disintegration and partly by phagocytosis, the whole larval respiratory system, with the exception of the spiral intima of the lateral longitudinal, and anterior and posterior transverse vessels disappears within a few hours after pupation.

The intima of the lateral stigmatic trunks is shed during moulting.

The Regeneration of the Tracheal System.

The regeneration of the imaginal tracheal system has kept pace with the destruction of the larval vessels, and takes place from the "imaginal nests" at the bases of the stigmatic trunks. At the end of the resting period of the larva, the cells composing these "nests," having lain dormant during the feeding period, rise into sudden activity, and proliferating greatly (fig. 89), extend as imaginal tracheal histoblasts inwards and along the intima of the great tracheal vessels, pushing the epithelial cells which the leucocytes have not removed aside as they advance, and taking up a position between the larval intima and the epithelial cells from which it was secreted (fig. 84). Some twelve hours later the epithelium of the larval intima has been completely regenerated (fig. 85). Those stigmatic trunks which are to persist in the imago undergo a similar renovation (fig. 89). In the others this does not take place, and they disappear (fig. 92).

The histoblasts are at first somewhat spindle-shaped as they advance, but they soon spread out and form a thin-walled tube in close contact with the spiral intima. The further history of this newly developed tracheal epithelium will be considered later.

Meanwhile the last abdominal spiracles have developed; not till this time, therefore, is the number of spiracles complete. They are formed each as a massive down-growth of very small cells which, passing inwards and forwards, develop a lumen and soon fuse with the main tracheal trunks; a spiral intima develops almost immediately.

In this spiracle the process of the development of the spiral intima could be clearly seen. The intima is secreted from the walls of the spacious lumen, and, when the surface of the cells which are secreting the intima is examined it is seen that they present strong ridges which fit exactly into the "spirals" of the intima which is being secreted, and just as in the markings of the general body surface, so here the spirals are merely the secretions formed upon a previously protoplasmic "mould." As the intima thickens the ridges on the cells gradually straighten out, and the outer portions of the intima, which are now secreted, are devoid of spirals.

It should, perhaps, be pointed out that the intima does not possess a true spiral structure, but is simply thrown internally into the form of a series of ridges, closely arranged, and giving the optical appearance of a spiral.

In connection with the spiracle of the twelfth abdominal segment, and also that of the propodeal (sixth) segment, a remarkable structure develops for the closing of its opening (text fig. G). A large number of cells of the massive ingrowth, which gives rise to the spiracle, arrange themselves in the form of a minute bent "clip," whose arms enclose the spiracle below. From them is secreted a chitinous bent rod, the two arms of which, very closely approximated for the greater part of their length, meet, and diverging again are strongly curved outwards distally; they thus form a complete ring round the trachea a short distance from its opening. The distal diverging portions are joined by a number of muscle fibres. By contracting, they can loosen the arms of the chitinous fork, and so bring about opening of the stigma, the distal divergence serving as a lever to increase the efficiency of the mechanism. This remarkable structure is distinctly visible in the adult wasp, if this has been rendered transparent by caustic soda. During pupal life the chitinisation of the spiracle increases, forming the well-marked structure of the adult.

It is necessary to return now to the further development of the main tracheal vessels.

In the larva some twelve hours after defaecation the larval tracheal epithelium has been wholly replaced by the imaginal histoblasts, which now extend as a new coating right along, and in close contact with, the larval tracheal intima (fig. 85).

But already before the epithelium has been completely renovated, the histoblasts at the anterior extremity of the longitudinal tracheal trunks begin to grow forwards over the numerous tracheoles which all open into the main trunks here; as many as eight tracheoles may converge towards this region and become enclosed together in the tracheal epithelium as it extends forwards. This process, which begins in the larva some eight hours after defaecation, advances greatly düring the next four hours, and, as a result, a distinct tube is formed, which encloses the tracheoles, which now appear in a state of degeneration. The appearance of the degenerating tracheoles has already been described; the products of degeneration evidently help to nourish the proliferating tracheal histoblasts.

The tracheal trunks, ceasing to extend straight forwards, now begin to grow downwards, and in their further extension travel quite independently of the tracheoles; they are seen four hours later as two wide channels running vertically down the head, parallel with and internal to the great head tracheoles, and often separated from these by the great ascending column of myoblasts—the developing musculature of the mouth appendages (fig. 91). So rapid has been their development that already at this period a "spiral" tracheal intima is partly developed.

Just before the tracheal trunks turn downwards two outgrowths are formed from them; of these one grows forwards, slightly outwards and upwards, and supplies the anterior, dorsal, and lateral regions of the head. The second branch grows out from the descending trunk a short distance below this dorso-lateral branch, and gives off a great branching tracheole into the brain. In the fresh pupa other tracheoles begin to grow out from this "cerebral trachea"; the structure and development of the imaginal tracheoles will be described later.

Tracheoles also entered into the developing antennae, while from the main tracheal trunks in the defaecating larva other tracheoles extend outwards into the legs and wings.

In the fresh pupa the great dorso-lateral air sacs begin to develop. The new tracheal epithelium just behind the first stigmatic trunk on each side begins to grow upwards as a slender column of cells. Cell division continues rapidly, and the columns extend further upwards, then backwards and slightly outwards, growing as a pair of narrow columns of cells, already showing a very distinct lumen, along the dorso-lateral regions of the thorax. In the two-day pupa they fuse again with the main tracheal trunks immediately in front of the propodeal stigmatic trunk

The tip of the column presents a remarkable frayed appearance (fig. 94); this may be a special adaptation to aid the column in forcing its way through the surrounding masses of fat cells.

The cell columns meanwhile have begun to differentiate. In the growing columns the cells are thick, rather elongated in the direction of growth, and present a clear cytoplasm; the lumen of the cell column is narrow and devoid of intima. But at about the time of fusion of the posterior end of the columns with the main trunks the epithelium gradually flattens, transforming the whole structure from a narrow tube into a great air sac (fig. 95). The epithelial cells develop a granular cytoplasm; while in the four-day pupa they may have nucleoli almost as large as those of the degenerating larval cells; a "spiral" intima is quickly secreted.

In the early pupa a number of other tracheae have developed from the main longitudinal vessels; especially prominent are two ventral downgrowths, from which the tracheoles of the wings have been developed. In the early pupa the anterior of these is observed as a thick column of more or less cubical cells, which in their descent have torn off and dragged along portions of the salivary glands as these were undergoing phagocytic destruction. A very fine example of this is shown in fig. 88; the great wing trachea is observed with fragments of salivary glands still attached to it; some of the tracheal cells are in a state of great activity and are growing outwards to form tracheoles; more anteriorly lie the larval tracheoles, undergoing disintegration.

The tracheal trunk to the hind wing is never so prominent.

While these tracheae and great dorso-lateral air sacs have been developing, the main tracheal trunks have undergone a similar differentiation. The epithelial cells gradually flatten out, and separating from the "spiral" intima of the larva upon which they have been resting for the last three days, soon form the two great ventral air sacs. A "spiral" intima is quickly secreted. The size of the air sac depends, of course, upon the degree of flattening undergone by the epithelial cells.

In the defaecating larva a third tracheal system develops (fig. 86), in the form of a pair of outgrowths, ventrally from near the posterior extremities of the main tracheal vessels. They grow out very rapidly; an upper branch supplies the intestine and neighbouring organs, while the main part of the vessel grows downwards and forwards, and undergoing special development in the female, ramifies among the muscles of the ovipositor (text fig. H).

In the pupa of the fourth day a transverse "commissural" trachea is seen uniting the main longitudinal air sacs; I have not observed the manner or time of its formation.

The old "spiral" intima of the larva can still be seen lying within the main air sacs, probably it disappears by being drawn out through the thoracic spiracles at the last ecdysis; it is certainly not present in the adult wasp.

The adult respiratory system (text fig. H) consists, then, of a pair of main tracheal vessels, dilated in the thoracic region into the ventral air sacs, and connected by three transverse vessels—one anterior, another posterior, the third a broad channel joining the two air sacs in their mid-region. Passing from the anterior to the posterior end of each ventral air sac is a great dorso-lateral air sac. From near the posterior end of the tracheae a pair of vessels pass downwards and forwards and supply the abdomen. The head is aerated by a pair of great tracheae which pass forwards from the main vessels and divide into three great branches in the head. From all these great vessels tracheoles are given off. Three pairs of stigmatic trunks, two in the alitrunk, the other in the abdomen, connect these tubes with the exterior.

The tracheoles of the adult insect, though essentially intracellular structures, are not such remarkable structures as we have seen in the larva. Certain cells of the developing tracheal tubes do not flatten out when these form an intima; on the contrary, they seem to grow in thickness, and then migrating from the epithelium grow outwards in various directions and ramify among the organs. They are the tracheoloblasts, but they never assume abnormally large dimensions. As they grow out from the tracheae (fig. 82) they leave tubes of varying width behind them (fig. 95); in the case of the smaller tracheoles the whole structure may remain unicellular. The larger tracheoles, however, such as those of the brain or of the appendages, are multicellular structures; their formation can be clearly observed in the legs. The nuclei of the small tracheoloblasts occasionally divide, and the cytoplasm between the two nuclei thus formed becomes drawn apart. This process is repeated several times and eventually the tracheole is seen as a narrow tube with a number of oval thickenings, the nuclei, along its path (fig. 103). The tracheoles are essentially protoplasmic structures: I could not detect, with any certainty, a chitinous intima. Frequently chromatic (?) granules may be observed within the walls of the tracheae between the nuclei.

The changes, then, which the respiratory system undergoes during metamorphosis—a re-development of the longitudinal trunks, the formation of a new spiracle, development of new tracheoles from tracheoloblasts, the production of the air sacs from purely embryonic cells, and, finally, the disappearance of ancestral stigmata—are identical with the changes which have been going on during early larval life (and probably during embryonic life, if these were known), or which would have gone on had the whole of the development from egg to adult taken place within the egg membrane. The significance of this will be discussed in the second part of this paper.

The destruction of the epithelium of the main tracheal vessels by leucocytes has been described by Pérez (1910) in *Calliphora;* but, so far as I am aware, the general disintegration and total renovation of the branching vessels have never been observed.

The conclusions of Breed (1903) and of Anglas (1904) that tracheoles are not formed as direct outgrowths from the main trunks appears to be quite erroneous, and the criticism of Poyarkoff, that Anglas was really dealing with myoblasts, seems to me entirely justified, since these cells in *Nasonia* frequently show a remarkable resemblance to small nucleated tracheoles.

THE MUSCULAR SYSTEM.

The history of the muscular system during post-embryonic life will best be considered under the following headings:—(a) The anatomy of the larval muscular system; (b) the structure of the larval muscles and their post-embryonic development; (c) disintegration of the larval muscles; (d) regeneration of the muscular system. The last section will be considered under various headings, *viz.:* (1) The longitudinal abdominal muscles; (2) the vertical abdominal muscles; (3) the pharyngeal dilators; (4) the muscles of the mouth appendages; (5) the muscles of the legs; (6) the ovipositor muscles; (7) the great thoracic muscles (muscles of flight); (8) the intestinal muscles; (9) the muscle insertions An examination of all these different muscles, moreover, will enable a comparison to be made between them.

The Anatomy of the Larval Muscular System.

Although the individual muscle fibres of the larva undergo a considerable amount of differentiation during larval life, yet the general anatomy of the muscular system does not alter. I shall describe it here as it can be observed in living larvae in the first instar, before they have become too gorged with food to be sufficiently transparent for observation.

The muscular system consists of three prominent sets of muscles: the great longitudinal muscles; the great transverse (oblique) muscles; and the masticatory muscles, including the dilators of the pharynx.

The longitudinal muscles (fig. 1) are in the form of twenty to twenty-two bands of muscles, passing from one end of the body to the other. Posteriorly where the body tapers off, they all tend to converge towards one point. Anteriorly they are inserted upon the walls of the first larval segment; here also they converge, but are less concentrated than at the hinder end. The muscles are arranged similarly on either side of the median line, and are quite absent beneath the ventral nerve cord.

The transverse (oblique) muscles (fig. 1) are in the form of nine pairs of muscles stretching from the third to the eleventh segments. They pass in hoops round the body of the larva, upwards and backwards; their lower and upper insertions are generally at the junctions of the larval segment with the segments immediately before and behind it respectively, *i.e.*, the oblique muscles are generally intra-segmental. This is not, however, entirely the case, as the last oblique muscle is inserted ventrally on the ninth segment, dorsally at the posterior limit of the tenth. Others also stretch over more than one segment.

The muscles of feeding are in the form of a number of structures which are inserted upon the pharynx at one end, while their other extremity is attached to the walls of the head, or to a specially thickened cuticular portion of it—the tentorium. They are the *dilators of the pharynx*. To the tentorium are attached also two very minute muscles which move the minute jaws. Only one muscle is attached to each mandible, the latter evidently swinging backwards, after functioning, as a result of the elasticity of the surrounding cuticle. There are six pairs of pharyngeal dilators. Of these the lower two are inserted upon the tentorium. Two other pairs, attached to the dorsal side of the pharynx, are inserted upon the dorsal head cuticle; while two other pairs radiate outwards towards the lateral head walls. The united pull of these muscles during feeding would dilate the pharynx considerably and would permit efficient sucking of the contents of the fly pupa, once the mouth was applied to the ruptured cuticle. In young larvae the dilators of the pharynx exhibit a thick dilatation along a considerable part of one side. This swelling becomes less prominent as the larva grows, but is recognizable even in adult larvae. Its nature will be explained later.

The Structure and Post-embryonic Development of the Larval Muscles.

The General Body Musculature.

The histology of insect muscle can be very clearly observed in material derived from *Nasonia* larvae, and as a number of structures, not hitherto observed, were revealed by the Haidenhain haematoxylin method of staining employed here, I shall briefly describe the structure of muscle fibres, as it occurs in this insect.

The longitudinal body muscles will be considered first. The portion of a single muscle band situated in any one segment, and inserted at its anterior and posterior extremities, is a single muscle fibre, containing three to five nuclei (and developed, as will be seen below, from as many cells). The inner, posterior portion of one muscle fibre, *i.e.*, of one intra-segmental muscle, is connected by a short process with a similar process given off from the outer, anterior part of the succeeding muscle (fibre) of the longitudinal band immediately internal to it (fig. 99), *i.e.*, there is a "dovetailing" of muscles (muscle fibres) not unlike what occurs in vertebrate cardiac muscle, which results in a direct communication between all the longitudinal muscle bands. This "dovetailing" is particularly clearly seen in young larvae and in the hind region of adult larvae. The connecting piece is always devoid of a nucleus (fig. 100), and does not, therefore, represent a distinct cell (see below).

When a muscle fibre is examined in sections, the longitudinal fibrillae are very clearly seen; each consists of a number of minute spindle-shaped sarcomeres (fig. 127), the "spindle" shape being due to the concentration of the fluid contents at its middle. At other times the liquid contents pass to either end of the sarcomere, leaving a clear space in the middle (Hensen's line) which may be quite wide. The two dots often figured on the ends of each sarcomere are optical representations of the extremities of the sarcomere (fig. 127). Moreover, Krause's membrane is apparently not a membrane so far as the muscle fibre is concerned; though the contrary view is sometimes held, it appears to consist rather of closely concentrated minute "dots," each representing the point of junction of successive sarcomeres. Fig. 127 shows a muscle portion of a fibre in longitudinal section; the individual sarcomeres, each a spindle-shaped structure, are clearly visible, and Krause's membrane is the effect obtained by the junction of successive sarcomeres approximately along one line. It is only with respect to the fibrils apparently that we can speak of a "Krause's membrane" as a *membrane* At any rate, Krause's "membrane" is developed by the individual fibrils, and, if adjacent "membranes" do unite, then the structure is secondarily, not primarily, a membrane I shall refer to this again in connection with the structure of the adult muscles

In connection with the "transverse" striations, a curious fact was noticed which has not, apparently, been hitherto recorded The striations do not run transversely across the muscle fibre; on the other hand, the fibrillae are so disposed that their thickenings in the fibre as a whole are disposed in the form of a *double spiral* (fig. 101). This double spiral is not always visible in longitudinal sections, as the muscle fibre may have been so cut as to show only a portion of it; under these circumstances it will appear either as true transverse striations or as a single spiral. However, in moderately thickly-cut sections the double spiral is almost always clearly visible. Moreover, it is possible to focus on top of a "transverse" striation, and beginning at one end and focussing alternately downwards and upwards, to travel right along the spiral, and finally arrive at the other end of the fibre. Also, after following a spiral striation through a single turn one arrives, not at the succeeding striation, but at the second in advance, showing the double nature of the spiral. By no conceivable bending or twisting of the muscle fibres could true transverse striations be thrown into this form, and the question of artefacts can be discarded; moreover, the double spiral may be detected in entire muscle fibres if these have been sufficiently stretched to allow the spiral on the distal side of the muscle to show through the thickness of the fibre

Krause's "membrane," of course, is likewise disposed in a double spiral.

The sarcomeres of either end of the muscle frequently have only one "Krause's membrane"; the outer end of the sarcomere being in this case inserted into the cuticle of the larva. Sometimes the fibrils can actually be traced into the cuticle, where they spread out a little to procure an extra hold (fig. 127). At other times they are inserted on to the terminations of integumental cells (fig. 100). The essentially integumental origin of the muscle insertions will be referred to later, in connection with their development.

Others of the fibrils, however, do not become inserted into the cuticle, but travelling across the border of the segment join fibrils from the next muscle of the same longitudinal band, forming a very powerful "Krause's membrane" at the junction (fig. 126). When a muscle is examined in surface view these crossing fibrils are clearly seen, giving the muscles a particularly frayed appearance at their extremities.

The muscles are covered with a very prominent sarcolemma.

The nuclei are three to five in number; they are round or oval flat discs; a very large nucleolus is usually present in the nuclei of the fully-grown larvae; or two nucleoli may be present; a karysome is quite absent and the chromatin is scattered in small granules throughout the nucleus (fig. 102a) The nuclei, if round, measure about 17μ in diameter; if oval, 19-20μ in length, 13-14μ in breadth. The breadth of the muscle is about 34μ; the length varies apparently according to the number of cells which entered into its formation; on an average the muscles measure about 250μ, so that the length of the individual "cell" composing the syncytium is 63μ.

The oblique muscles possess four nuclei; in their middle they show a long slit, indicating the double origin of this part. Their minute structure does not differ from that of the longitudinal muscles.

If the muscles of young larvae be examined, the essentially multicellular nature of the muscle fibres is clearly seen (fig. 100). Three to five cells may be present arranged end on end, and the cell boundaries are still unmistakable. In the earliest stage (twelve-hour larva) in which I have examined them they show distinct longitudinal fibrillation, the fibrillae of successive cells in the developing syncytium already fusing. Moreover, fibrillae from one fibre have already communicated with those of others of the muscle band. Striations are just beginning to appear; in some they are distinctly visible, in others quite absent. The individual cells measure 14μ in length, 11½μ in breadth. The nuclei are relatively gigantic and measure 12-14μ long by 8-9μ broad. Nucleoli are quite absent; one or more small karyosomes may be present, but a considerable part of the chromatin may be scattered in granules throughout the nucleoplasm (fig. 102b).

Already at this stage, too, the connecting pieces can be clearly seen between the adjacent muscle bands. In the oblique muscles the four-celled condition is especially clearly seen (fig. 99).

The muscles grow rapidly; already in the second instar the cell limits are scarcely visible. From now on the muscles begin to differentiate into the condition in which we see them in the adult. The process consists mainly in a special development of the striations, and a general "loosening" of the texture of the whole muscle by the development, apparently, of more interstitial substance. The nuclei grow considerably in size, *but the actual chromatin does not appear to increase* *in quantity;* karyosomes disappear and the nucleoli develop in their place (fig. 102a and b).

Although the adult muscles may be inserted upon the cuticle directly, yet there can be no doubt that such insertions were originally integumental cells. Leydig (1885) first put forward this view, and it is held by Duboscq (1898), Henneguy (1906), Janet (1907), and Pérez (1910). Others have regarded the fibrillae as fusing directly with the cuticle, but this view seems scarcely tenable.

If the muscles of young larvae be teased out, it is frequently possible to observe the fibrils of the longitudinal muscles communicating with the cytoplasm of a long process from the flat integumental cells (fig. 100). These processes show a considerable degree of chitinisation, and may apparently chitinise fully before the end of larval life, thus explaining the insertion of fibrillae upon a non-protoplasmic surface.

The Dilators of the Pharynx.

If a larva in its first instar be examined these muscles can be observed in the last stage of development (fig. 47). The muscles are formed, probably in late embryonic life, from a mass of cells which fuse to form a syncytium. Generally about four to five cells combine thus, though in some cases as many as fourteen to sixteen (judging by the number of nuclei) fuse. I have not examined these muscles earlier than half-way through the first instar. At that stage the "transverse" striations are clearly seen, again in the form of spirals. The nuclei all become concentrated in one place, and collecting a certain amount of cytoplasm round them, form the large swellings already mentioned. Each nucleus has a large karyosome.

The spiral striations do not extend on to the dilated part of the cytoplasm; they are confined to the essentially contractile region of the muscle. Along this region fibrillation has been taking place, but is not yet, apparently, complete, for the spirals extend outwards, upon otherwise quite undifferentiated protoplasm (see fig. 47, at x). Here, then, it seems that the (spiral) striations form first in the contractile syncytium, and the longitudinal fibrilliation is only secondarily developed. In the general body muscles the opposite happens; this appears to be the case also in mammalian muscle.

Sometimes a single cell of the syncytium may form a number of distinct roots of the muscular portion of the insertions. As in the body muscles, the muscle fibres are always inserted upon the integumental cells, never directly upon the cuticle.

The Destruction of the Larval Musculature.

Like the other highly specialized larval organs, the larval musculature undergoes total destruction at the end of larval life.

The muscles of the larva do not, however, all disappear simultaneously. The pharyngeal dilators disappear first, at about the time of larval defaecation. Certain thoracic muscles begin to disintegrate several hours later. The abdominal muscles persist till a few hours after pupation.

(1) *The Dilators of the Pharynx.*

The disappearance of these muscles is closely associated with the development of the pharyngeal muscles of the imago, and will be more conveniently described there.

(2) The disintegration of the *upper three pairs of thoracic muscles* and of the *oblique thoracic muscles* is closely connected with the development of the great vertical and longitudinal thoracic muscles, and will be considered in connection with these. The other thoracic muscles disappear early in larval life. I have not, however, carefully examined their process of destruction. It is improbable that this should be unlike the process as we see it in certain abdominal muscles, which I shall here describe carefully.

(3) *The Muscles of the Abdomen.*

Many of the longitudinal muscles of the abdomen of the larva are disintegrated by the action of the embryonic cells of developing imaginal muscles. The description of these will be deferred till the regeneration of the muscular system is considered.

On account of the marked differences shown by the vertical (oblique) and longitudinal abdominal muscles in their mode of disintegration, it will be best to consider them separately.

(a) The Longitudinal Muscles.

It is mainly in the ventral portion of the abdomen that disappearance of the longitudinal muscles independent of the action of developing myoblasts occurs.

Though the process first becomes marked in freshly formed pupae, yet, for a considerable time previous to this, the muscles have been undergoing a process of internal degeneration.

In the larvae at about the time of defaecation the nuclei begins to appear abnormal; they have developed great nucleoli, much larger than those usually occurring in nuclei, which may be, at this stage, crowded with numerous minute highly refractile crystals. Most of the muscles, however,

appear otherwise quite normal, and are still capable of functioning, though only very feebly. (The shedding of the last larval cuticle is itself brought about by muscular movements of the abdomen.)

Shortly after moulting, however, the muscles lose their striations, the substance of the striations spreading itself uniformly through the fibrils (the substance of the fibrils becoming, in consequence, uniformly heavily staining (fig. 107).

The nucleus meanwhile undergoes certain changes; the chromatic material of the nucleus may change from a rough granulation to a fine chromatic dust, the particles of which may be clumped together (fig. 107). This dust may be forced into the cytoplasm. It may even scatter itself through the substance of the muscle, leaving only the empty nuclear membrane behind. This occurs in certain of the dorsal abdominal muscles whose further disappearance is intimately related with developing myoblasts, and is rendered possible by the degeneration of the fibrillae into a loose granular fluid.

At other times, however, the nuclei remain, to external appearances, normal, except for the presence of the great nucleolus.

At about the sixth hour after pupation those muscles which have not become penetrated by the myoblasts of developing imaginal muscles (see below) are fallen upon by leucocytes (fig. 105).

The leucocytes begin to cluster around the dead muscle fibres and the muscles are rapidly absorbed. Pérez has examined the process fully in *Calliphora,* and I shall describe it only briefly here, referring mainly to the points of difference as seen in the two insects.

When the leucocyte has approached close to the degenerated muscle it pushes out a pseudopod which appears to dissolve its way through the still unbroken sarcolemma. Within the muscle it gradually swells out and drags a certain amount of the leucocyte after it; so far as I could observe, it does not entirely enter the fibre (fig. 129).

The actual penetration of the leucocyte into the muscles occurs infrequently. Much more often the leucocytes content themselves with clustering around the sarcolemma where it has been ruptured by the more adventurous ones, dissolving off small pieces there, which accumulate within the leucocytes, in the form of large granules.

Occasionaly, however, a much more voracious leucocyte may engulf long strips of muscle substance; so long, indeed, may the strips be, that it becomes necessary to bend them about to accommodate them within the body of the corpuscle;

sometimes several such strips may be present. Most usually, however, the leucocytes remove the muscle tissue in much smaller quantities. Pseudopodia, however, are very rarely seen; although the absorbed food is frequently contained in a vacuole, and although it is possible that during the killing of the leucocytes, in making the preparations, pseudopodia may have been withdrawn, it is nevertheless quite probable that a considerable amount of feeding takes places by the absorption of liquid material, perhaps dissolved by extra-cellular enzymes directly through the walls of the leucocytes. I shall refer to this again later.

That the muscles, once their sarcolemma has been ruptured, may undergo a certain amount of "chemical disintegration" is not unlikely; it might, however, be very difficult to detect microscopically. In the case of the vertical abdominal and the pharyngeal muscles, however, it does occur, and is fairly easily seen (see below). Nevertheless, the main factor in the removal of the degenerated fibre is the phagocytic action of the leucocytes. These scavengers, having gorged themselves at the expense of the dead tissue, gradually move to some secluded corner in the cavity of the appendages, or amongst the developing integumental cells, and there attempt to digest their meal in peace.

The removal of the dead muscles is accomplished within several hours; ten hours after pupation they have entirely disappeared.

(b) The Vertical (oblique) Abdominal Muscles.

Although myoblasts may, in the anterior part of the abdomen, develop in relation with some of the degenerating vertical muscles, yet the appearances which these present, as they disintegrate, are quite different from those which we see in the longitudinal muscles.

The nuclei present the usual features of a greatly hypertrophied nucleolus, often containing numerous minute crystals. The contractile part of the muscles may disintegrate at a remarkably early period, *viz.*, in the defaecating larva; at other times distinct striations may still be seen a day later. Almost invariably, however, the striations have disappeared from the muscles sixteen hours after defaecation, and the resulting appearance of the muscle depends upon whether the contractile substance has been cast bodily out of the fibre, or whether it has become uniformly scattered along the fibrillae. Both these processes occur. I shall first describe the former.

It was in one of the posterior abdominal muscles in the larva at about the time of defaecation that I was able to observe the process of disappearance of the striations. The muscle is reproduced in fig 104. In the lower region of the muscle the spiral striations are still visible, as heavily staining thickenings of the fibrillae, and are still, to all appearances, quite normal In the upper part of the muscle the striations have entirely disappeared In their place the whole muscle is filled with a fine dust of disintegrating striated material which is being thrown in a shower of particles, at first sight resembling bacteria, into the blood stream Some of the striations in the individual sarcomeres are still intact, and may be arranged apparently quite normally, successively along a fibril Others, already shortening, lie in the interstitial substance, where they are quickly rounded off, and by the time they reach the blood stream, are seen simply as minute rounded globules, evidently undergoing solution in the blood plasma The striated substance has not been pressed out at the end of the fibril; it seems to burst its way through in each sarcomere, apparently in the region of junction of successive sarcomeres ("Krause's Membrane").

This loss of material causes a considerable shrinking of the contractile substance within its sarcolemma.

At other times, the muscles do not lose their staining reaction; on the contrary, though their striations disappear, the fibrillae (?) stain quite strongly, and it is seen that the striated substance, instead of forcing its way through the muscle sheath, has now spread itself along the fibrillae. The latter process appears to be much the commoner of the two. Exactly what determines which of the two processes should occur I am quite unable to say.

Degeneration of the muscle fibre now continues; the sarcoplasm becomes granulated and develops, in places, rounded globules. Quite frequently these globules absorb a granule into their middle, which may give them the appearance of minute nucleated cells. Such a condition has already been described in the degenerating integumental cells The sarcolemma may have become strongly wrinkled.

As a result of the degeneration of the interstitial substance the fibrillae become pressed close together. Leucocytes now penetrate the sarcolemma and a phogocytosis of the interstitial substance commences. A considerable part of it, however, undergoes chemical disintegration, being cast into the body cavity as large round globules, which are not to be confused with globules from the fat-body (fig. 110).

As a result of this process the fibrillae are set free, and falling apart, spread out a little, producing structures of very characteristic appearance (fig 110). Sometimes, it would seem, several fibrillae cluster together, and the muscle is represented not by the loose individual fibrils, but by a number of loose bundles, each consisting of a few fibrillae which have become fused together.

Having removed the more palatable interstitial substance the leucocytes now turn their attention to the fibrillae The process of destruction seems to be much more difficult here. The leucocytes apply themselves round a piece of the fibril, and several such leucocytes may often be seen, arranged side by side along a single fibrilla in their attempt to destroy it. The process is actively going on in the fresh pupa, and six hours later the fibrillae have entirely vanished Muscular regeneration often occurs in connection with these degenerating fibres and will be referred to below.

The histolytic action of the phagocytes on the muscles was first discovered independently by van Rees (1884), and by Kowalevsky (1885), using *Calliphora* as material. Korotneff (1892), on the other hand, could not observe it in the moth *Tinea*, but his observations were made on the thoracic muscles. He regarded these, apparently erroneously, as arising by regeneration of the larval muscles. Berlese's conclusions have already been referred to earlier

In *Calliphora* Pérez finds that the leucocytes generally enter the muscles, and break off small pieces of muscle This muscle has not undergone any visible degeneration, even within the leucocytes it seems to retain its structure for a considerable period. In *Nasonia* the degeneration of muscles preceding the phagocytosis invariably occurs, and all stages of disorganization from muscles which have merely lost or even only incompletely lost their striations, to others which have undergone total granular degeneration, may be observed.

The Regeneration of the Muscular System.

An examination of the process of regeneration of the muscular system revealed the remarkable fact that a considerable difference exists in the actual morphology of the various muscles of the adult wasp; the muscles of the legs, ovipositor, and mouth appendages have similar methods of development, and though the mature surface abdominal muscles are similar to these, their mode of development is quite different. A single pharyngeal dilator muscle, on the other hand, corresponds not to a single leg muscle, but to a whole group of them; while the great thoracic muscles (wing muscles) are quite unique in that they are composed of a great many muscle fibres, all running parallel to one another, and quite devoid of fibrillae. These remarks will become clearer when we have considered the development of the various muscles; it is enough to say here that failure to observe the muscles in their embryonic state has resulted in a considerable misinterpretation of the structure of the mature organs.

The adult muscles all arise from mesodermal cells, the myoblasts, which are recognizable in the earliest larvae. The assertion of de Vaney (1902) that these cells are hypodermal in origin, is quite erroneous, and the opinions of Kowalevsky (1887), Berlese (1901), Henneguy (1904), Karawaiew (1898), Pérez (1910), and finally of Poyarkoff (1910), that they are essentially mesodermic cells are easily verified in *Nasonia*.

(1) *The Superficial Longitudinal Abdominal Muscles.*

As the most direct development of adult muscles occurs in the superficial abdominal muscles, it is best to consider these first.

In the fresh pupa, the longitudinal abdominal muscles begin to degenerate. After losing their striations the fibrillae cluster together in the middle of the muscle, while the interstitial substance, which in life separates them, becomes forced to the periphery of the muscle fibre, appearing here as a granular fluid, after showing fatty globules (fig. 107). At other times the whole muscle fibre, not merely its interstitial substance, may undergo granular degeneration, and the chromatic material, breaking out of the nucleus, may scatter itself as fine granules amongst the degenerate cytoplasm. The sarcolemma remains intact (fig. 108). Some of these muscles undergo phagocytic destruction, as above described. It is to the remainder that I refer here.

The myoblasts now become active. During larval life these have been lying, as small embryonic cells, 5μ to 6μ in diameter, scattered in the body cavity close to the muscles. They now begin to multiply, mitotically it seems, and, penetrating the sarcolemma, lie in the degenerated muscle cytoplasm (figs. 106, 108, 109), where they move about by amoeboid action (fig. 107).

Within the muscle fibre these cells multiply, and grow at the expense of the degenerate larval muscle substance. In those muscles where there has occurred a total cytoplasmic degeneration their task seems comparatively easy; but in those muscles where the fibrillae have failed to disintegrate they at first confine their attention to the granular interstitial substance. Eventually, however, the whole larval muscle (fibre) disappears, including even the sarcolemma, and the myoblasts are seen in its place. The cytoplasm of the myoblasts is always clearly seen, and pseudopodia are often visible (fig. 107); but whether the myoblasts absorb the muscle cell contents phagocytically, or whether they merely absorb it through their permeable cell wall, I am unable to say. Perhaps, after all, the only function of the pseudopodia is to enable the myoblasts to crawl into the position they are to assume in the mature muscle, just as the cells of the imaginal integumental areas do (see above).

It is scarcely necessary to remark that the myoblasts in the above account have not been confused with leucocytes, the activities of which are not altogether unlike those of the myoblasts; leucocytes are considerably larger than myoblasts and always have a characteristic nucleus.

After twelve to fifteen hours the myoblasts of each muscle fibre have arranged themselves, one after the other, in a row; the pseudopodia have entirely disappeared (fig. 111) and the cells are almost cubical in shape. In this condition they remain for a long time, the only visible change being that they first adopt a very regular arrangement, and in the thirty-six hour pupa fuse to form a long columnar syncytium, with the nuclei regularly arranged along it from one end to the other (*cf.* fig. 115). But in the middle of the third day of pupal life the developing muscle fibre begins to differentiate, and first undergoing fibrillation, then striation, develops eventually into the muscle as we see it in the adult The striations, as usual, are spirally arranged The nuclei occur right in the middle of the fibre (fig. 116) It follows, of course, that a single longitudinal abdominal muscle consists of only one fibre.

The nature of the muscle insertions will be referred to later.

Pérez (1910) has observed the metamorphosis of the abdominal muscles in *Calliphora.* He finds that the muscle fibres lose their striations and fibrillations, and that even the sarcolemma is added to the degenerate mass. He described the myoblasts as entering the dead larval muscle fibre apparently by amoeboid action. Here they lose their cytoplasm and increase by direct division to form the syncitial mass, which, on differentiating, produces a mature muscle fibre. It should be remarked that the myoblasts have only an extremely fine pellicle in *Nasonia*, and that if the degenerate larval cytoplasm is at all compact in consistency, as it is in the pharyngeal and thoracic muscles, the myoblast cytoplasm is hardly, or not at all, distinguishable, unless, as is very often the case, the myoblast lies in a distinct vacuole within the mass, part of which it has, apparently, been absorbing. The degenerate cytoplasm of the abdominal muscles is, however, so loose in texture that the cytoplasm of the myoblast is easily recognizable. The apparent loss of cytoplasm as described by Pérez, moreover, would be difficult to interpret in terms of our usual conception of a living cell.

(2) *The Vertical Abdominal Muscles.*

The development of these muscles takes place in close relation with the degeneration of the vertical (oblique) abdominal muscles of the larva, which, as described above, after losing their cytoplasm, break up into vertical fibrils or groups of fibrils. While these fibrils are undergoing phagocytic destruction the myoblasts crawl along some of them and, nourishing themselves at their expense (fig. 110), ultimately form a column of myoblasts similar to those seen in the longitudinal muscles; these on differentiating form the vertical abdominal muscles whose structure does not differ from that of other muscles of the abdomen. They are especially well developed at the anterior extremity of the abdomen, where they become attached in front to certain small phragmas within the petiole, and act as the flexor and extensor muscles of the abdomen

(3) *The Dilators of the Pharynx.*

The larva possesses six pairs of pharyngeal dilators (muscle fibres) to whose development I have already referred. In their neighbourhood, even in the earliest larvae, can be seen occasional myoblasts measuring usually some 5μ to 6μ in length.

Like the other purely larval cells, the pharyngeal dilators undergo degeneration, this occurring at the time the larva defaecates; but their disintegration differs somewhat from that of the muscle fibres of other parts of the body. The nucleus presents the usual hypertrophied appearance, and contains the gigantic nucleolus, so characteristic of the degenerating cells. As in the case of the abdominal muscles, the pharyngeal dilators, after degeneration, become the prey of the proliferating myoblasts of the imaginal muscles. But before they penetrate the muscles these often undergo a partial globular degeneration, and those globules, breaking through the sarcolemma, are in part cast into the body cavity, where they dissolve in the blood (figs. 117, 118, 119). Sometimes several such globules, floating about in the blood, may be gathered up by a leucocyte, if one happens to be present (fig. 119).

Only a portion of the muscle fibre, however, disintegrates in this way; some muscle fibres, indeed, hardly change their appearance, the only indication of disintegration being the refusal of the striations to absorb stains; and between these two extremes all conditions of degeneration may be observed —from fibres which lose their striations but retain their fibrillation, to others which undergo total disorganization, but fail to cast their contents into the body cavity.

In the larva at about the time of defaecation the myoblasts, which may often be in the form of spindle-shaped cells, proliferate rapidly (fig. 117), and an occasional myoblast may be observed entering the degenerate muscle. The rupture thus made serves for the entrance of the myoblasts, and soon several groups of myoblasts, now quite round, may be observed, one behind the other, all lying in the path cleared by the first myoblast (fig 121). The cytoplasm of each myoblast is, contrary to the observations of Pérez, usually clearly visible, lying within a clear space which it has excavated out of the muscle substance and the former contents of which it has apparently absorbed (fig. 121). Frequently, however, the cytoplasm of the myoblasts is so similar to that of the disintegrated muscle substance that its limits cannot be recognized. More and more myoblasts penetrate the muscle fibre till, in the larva eight hours later, the whole muscle is riddled with embryonic cells; the sarcolemma seems to be absorbed also. During the remainder of larval life the myoblasts, after absorbing the remnants of the granulated larval muscle, arrange themselves in several columns of cells; the cells may be slightly spindle-shaped, at other times brick-shaped, and each column is to be considered the equivalent of one developing muscle fibre such as I have described in the abdomen; the pharyngeal dilator muscles, in other words, are multifibrous structures, of much greater complexity than the ordinary abdominal muscles. By this process six pairs of pharyngeal muscles of the adult are laid down; two other pairs are developed from myoblasts which appear to grow quite independently of the larval muscles. At any rate, eight pairs of muscles are to be observed in the newly formed pupa (see fig. 154).

In the fresh pupa the muscles begin to differentiate. Each column of cells becomes a long columnar syncytium, just as occurs in the abdominal muscles, so that in the fresh pupa the developing muscle consists of a number of syncytial columns packed close together (fig. 122). Each column then undergoes longitudinal fibrillation, and the whole muscle, losing all indication of the individual columns, becomes a uniform mass of longitudinal fibrillae. The whole process goes on very rapidly, and all stages from a non-syncytial mass to a true fibrillated mass can be observed in the fresh pupa. Even at this time distinct indications of striations can be observed, each fibril breaking up into alternate elements, one of which stains feebly with haematoxylin, the other with eosin. No distinct Krause's membrane in the individual fibrils can yet be observed. Sometimes the muscle fibrillae, even before losing their intra-columnar grouping, may show indications of striations. Sometimes muscle fibres may even be observed, one end of which has undergone striation, while at the other end striations have not yet developed (fig. 123). The visible changes in the development of the contractile part of these muscles during the rest of pupal life consists in a greater strengthening of the striations and the development of Krause's membrane.

Meanwhile the nuclei have moved from within the muscle to the surface, where they lie often in quite prominent masses of uncontractile cytoplasm (fig. 123). The interstitial substance of the muscle fibres seems to be produced by the only partial fibrillation of the syncytical columns.

The outer walls of the fused mass of myoblasts remain as the sarcolemma.

The development of the muscle insertions is quite simple. Each syncytial column, before fibrillating, fuses with a process, several of which may be formed, from the adjacent integument. In the late larva these processes are quite long, but already in the fresh pupa they have begun to retract (fig 122), evidently exerting a pull on the muscles shortly before these differentiate. They soon shorten to the thickness of the other integumental cells, and during the third and fourth day chitinise, giving the muscle insertions the appearance of being inserted directly on the chitinous exoskeleton.

By this process the eight pairs of pharyngeal dilators are produced (fig. 124). In structure they are intermediate between that of the abdominal muscles on the one hand, and that of the muscles of the mouth appendages and of the leg muscles on the other. It would seem, indeed, that these muscles have been evolved from muscles which once resembled the pharyngeal dilators.

The development and structure of the muscles of the mouth appendages and legs, and others similar to them, must now be considered.

(4) *The Muscles of the Mouth Appendages.*

The development of these muscles illustrates a mode of formation which differs somewhat from that observed in the other muscles above described—a method of formation which is to be observed also in the muscles of the legs and of the ovipositor.

Even in the earliest larvae scattered embryonic cells, with clear cytoplasm and large "vesicular" nuclei, may be observed in the ventral portion of the head, in the neighbourhood of the mouth appendages or their imaginal discs.

They are distinguishable from the leucocytes on account of their smaller size (about 6μ) and the clearness of their cytoplasm, which is quite devoid of vacuoles.

During larval life these cells—the myoblasts of the future head muscles—proliferate, but do not appreciably change their size or appearance. Whether proliferation is confined to the last stages of larval life, or whether it occurs gradually throughout larval life, or, lastly, whether it occurs only at the time of moulting, I have not observed. At the time of defaecation, however, the myoblasts have proliferated greatly, and still dividing mitotically, grow upwards and backwards behind the brain as two slender columns of cells (figs. 91, 154); in the larva eight hours later they have crept right up the back of the transforming head, and finally reached the dorsal surface. The cells in the lower portions of the columns have consolidated themselves, and now form a well-defined rod. Those at the growing ends are loosely arranged and generally long and "spindle-shaped." Sometimes they are exceedingly long, and apparently represent the cells which both Breed and Anglas mistook for tracheoblasts. In growing upwards they move along, and support themselves upon, the degenerate larval tracheoles (fig. 91).

In the twelve-hour larva these spindle-shaped cells have all adopted the shape characteristic of the other cells of the columns; further cell proliferation results in a thickening of the columns.

Although the columns have supported themselves, as they grew upwards, upon the great larval tracheoles, they soon stand quite independent of these. This appears to occur at the time when the most dorsal cells have fixed themselves to the ectoderm of the apex of the head. In the larva eight hours before pupation the columns have become intimately associated with these ectodermal cells. The remainder of the development of the head muscles is intimately associated with that of these muscle insertions.

In the pupa in the first day of its existence the cells of the two great columns have grouped themselves into a number of secondary columns, by the regular arrangement of successive cells one above the other. There are thus formed, still within the limits of the original columns, numerous secondary columns each one cell in thickness; each of these columns will become a single muscle (fibre) of the head.

The dorsal extremities of the two columns, it would seem, begin to spread out a little and meet the processes from adjacent ectodermal cells—the future muscle insertions. These are at first quite long, and even in the larva eight hours before pupation may be observed converging from a considerable area of the apex of the head (fig. 154), all upon the narrow cell column. During the first day of pupal life ectodermal cells still more distant—on a great part of the posterior, and also lateral, regions of the head—elongating considerably, insert their processes upon the secondary cell columns. These processes then apparently contract again, and the tension exerted by these appears to overcome that which holds the secondary columns together; they break apart, and, the ectodermal insertions contracting more and more, drag these columns into the positions they are to occupy in the adult insect (fig. 114).

At their lower extremities the spreading out of the cell columns is much more limited; they do not encroach upon large areas of the ventral portion of the head, but confine themselves to the mouth appendages, which have meanwhile developed, and in close contact with which they have always been

Even in the pupa in its third day the cell columns may still be observed in this condition The ectodermal insertions have retracted, and evidently exert a considerable tension on the columns. These are seen to consist of about eighty cells, arranged one behind the other; only the outer cell walls have persisted, so that they now form each a syncytial column, already visible as such in the thirty-six hour pupa Each nucleus has a distinct karyosome, lying within the slightly granular nuclear space.

During the fourth day of pupal life the muscles begin to show striations—again of the spiral type—and the muscle passes into its adult condition (fig. 116). The persisting cell walls remain as the sarcolemma.

The labium is provided with a set of powerful muscles which have probably been formed from the great cell columns; during early pupal life they become inserted on the posterior wall of the head, just above the labium.

In the proximal joints of the antennae, myoblast cells, which in the early larva were dragged into the antennae as these grew outwards, form, in the defaecating larva, a cell column in the basal joint of each antenna. These cell columns, growing backwards, meet the lower portions of the integumental ingrowths which produce the great cephalic phragmas already referred to, and spreading out in a number of separate columns on these (fig. 43), produce, by a process similar to that above described, the muscles of the antennae. It should be noted that only the first joint of the antennae is provided with muscles. The cephalic phragmas are strengthened by the attachment to their posterior surface, of certain of the muscles of the mouth appendages.

(5) *The Leg Muscles.*

The essential features of the development of these muscles are similar to those observed in the head muscles. They need, therefore, to be referred to only briefly here.

Excepting the tarsal muscles, for the present, the leg muscles are in the form generally of two sets in each segment of the leg (fig. 16). Of these one pulls the segment which it moves in one direction, the other in the opposite (fig. 18) Since, moreover, the joints are of such a nature as to limit the extent of movement in one of these directions, while the muscles are so disposed as to cause only motion in one particular direction, for each muscle, it becomes possible to speak of the one as a *flexor* muscle, and its antagonistic one as the *extensor*, the extensor being that one whose activities are limited by the peculiar mode of articulation between the segments.

Of these muscles, a pair, the flexor and extensor tarsi, are developed in the tibia, and in the femur the corresponding muscles of the tibia are developed. In the trochanter only one muscle, the extensor femoris, is formed (fig. 17). The coxa contains the flexor femoris, as well as, apparently, certain other muscles (fig. 16). Proximally these muscles are all spread out over a large part of the segment, while their distal portions converge and are attached to a tough tendon fibrillated in structure, which is inserted upon the upper part of the next segment. This suggests, of course, a mode of development similar to that observed in the head, and the two processes are, indeed, very much alike.

As the hollow leg-discs grow out from the body in the late larva they drag a mass of myoblasts, which lie in close contact with the leg-discs throughout larval life, after them. In the defaecating larva, while the legs are yet very short, these have grouped themselves in each segment in opposite columns, in the position they are to assume in the adult, *i.e.*, we get the rudiments of flexor and extensor muscles. As in the head muscles, the myoblast columns, whose cells continue to divide mitotically, grow in thickness In the pupa six hours after defaecation, *i.e.*, earlier than in the head muscles, the upper ends of these muscles become dragged apart by the integumental cell insertions. By this means cell columns, each corresponding to a single component of one of the two muscles of each segment, are produced, the proximal ends are spread out, the distal insertions remain together and become inserted on the tendons. The muscle columns form syncytia in the usual way, which, developing striations, transform themselves into the muscles as we see them in the adult. The outer cell walls persist, of course, as the sarcolemma.

The tendons correspond morphologically to the body phragmas They are formed as columnar ingrowths from the integument, and even in the thirty-six hour pupa still have an embryonic appearance

The tarsus is provided with a long tendon (fig. 46), inserted proximally on the great tendon of the tibia, while distally it is inserted on the last segment. It is not unlike a tracheole in appearance, in each segment it is dilated, this portion bearing the nucleus In the first and fourth segments the tendon gives off smaller branches to the walls Only the fifth segment has a muscle, which moves the claws

The tendon is formed as an ingrowth of cells in the early pupa (six hours old) which extends right along the tarsus and fuses with the tendon of the tibia.

(6) *The Muscles of the Ovipositor*

In the female there is a remarkable development of muscles in the ventral part of the abdomen, which extrude and hold the ovipositor in position during egg laying.

From the great phragma at the upper extremity of the ovipositor two great systems of muscles pass to the lateral body walls (fig. 22). From the lower phragmas other great masses of muscles pass to the ventral and lateral regions of the abdomen and are all so disposed as to hold the ovipositor with a maximum rigidity while this is boring its way through the hard shell of the fly pupa in which the insect is ovipositing.

The mechanism of retraction of the ovipositor is very simple. As already described, the ovipositor drags down the sternal plate of the preceding segment during oviposition in the form of a cone. On the sternum a pair of enlarged longitudinal abdominal muscles from the petiole are inserted. The pull which these exert on the sternal plate forces the ovipositor back to its position of rest.

The structure of these muscles is identical with that of the head and leg muscles. Their development is quite similar.

In the defaecating larva the myoblasts which have throughout larval life lain in this region, proliferate rapidly by mitosis. In the fresh pupa they form a solid column of cells which passes right along the ovipositor; two pairs of smaller columns are seen at the sides of this column. These columns then break up in the usual way, being dragged into position by the adjacent integumental cells. Spiral striations appear as usual.

(7) *The Muscles of Flight.*

These are the most remarkable, and at the same time morphologically the least understood, of the insect muscles.

Their transformation during metamorphosis has been studied more frequently than that of any other organ; nevertheless our knowledge of the process, in spite even of the recent work of Pérez, is far from correct. Even the name "wing muscles," by which they are generally known, is inaccurate, though their function is to move the wings, they usually have no direct attachment to these. Most of the observations have been made on the blow-fly, *Calliphora*, and it is therefore possible to compare the observations of the various authors.

Kowalevsky (1885) regarded the larval thoracic muscles as undergoing phagocytic destruction along with the other specialized larval organs; the imaginal muscles he regarded as being rebuilt from a number of mesenchyme cells, lying free within the body cavity.

Van Rees (1889) observed that three of the longitudinal thoracic muscles did not disappear; on the contrary, their nuclei, he believed, underwent multiplication, while the muscle itself appeared to possess a resistance against leucocytes. The newly formed nuclei became spherical, and migrating into the muscle substance, transformed this into the muscle as it occurs in the adult.

Korotneff (1892), working with a moth *(Tinea)* concluded that the mesenchyme cells found by Kowalevsky were superfluous structures in that insect. He could find no trace of them in the moth, and believed he could confirm Van Rees' observation on the rejuvenescence of muscle nuclei. The contractile part of the muscle fibres, as a result of constant functioning during larval life, became exhausted, and underwent granular degeneration, forming long plasmatic columns ("Plasmastrang"). The rejuvenated nuclei penetrated into the mass and formed a separate nuclear column ("Kernstrang"). These gradually reorganized the disintegrated myoplasm, and eventually formed the adult muscles. Leucocytes took no part in the transformation.

Pérez (1910) re-examined the metamorphosis of the thoracic muscles of *Calliphora;* while confirming the observations of Van Rees and of Korotneff that certain larval thoracic muscles did not disappear, he attributed to these quite an insignificant function in the rebuilding of the adult thoracic muscles. He regarded them merely as the "scaffolding" on which the imaginal muscles arranged themselves. To the "rejuvenated nuclei" of Van Rees and Korotneff he attributed quite a different origin. They were the mesenchyme cells of Kowalevsky, and bore no relation whatever to the larval nuclei. These myoblasts, as he now called them, migrated into the degenerate muscle mass, lost their true cell walls, apparently, and growing at the expense of the larval muscles, and probably nourished also by the surrounding blood, formed a great syncytium, on the outside of which the nuclei then arranged themselves. This syncytial mass then broke up into five longitudinal masses, and the further breaking up of these masses into longitudinal *fibrillae* led to the formation of structures which, on further differentiation, became the adult muscles of flight.

These conclusions of Pérez are undoubtedly more in harmony with our conception of the nature of cells, and in the main I have been able to verify them; his observations, however, on the differentiation of the great syncytial masses are, I believe, quite incorrect; the process as I have seen it in *Nasonia* is certainly entirely different.

Special attention has been drawn to the flying muscles of insects by Schäfer (1891), who has formulated a theory of muscle contraction on the basis of certain structural arrangements which he observed in the "fibrillae" of the flying muscles of insects. The development of the great thoracic muscles of *Nasonia* shows that in homologising the "fibrillae" of the flying muscles of the insect with the fibrillae of other muscles, Professor Schäfer was incorrect;(5) at the same time, the false homology will in no way discredit his conception of muscle action. The thoracic muscles of insects, indeed, are perfectly unique, and deserve to rank, I believe, with the other types of contractile structures—plain, striated, and cardiac muscles—as a fourth type of muscle fibre, in which, though striations are present, fibrillae are entirely absent. The flying muscles of the insect are to be regarded not as consisting of a great number of *fibrillae* with remarkably complex structure, but rather of great numbers of *fibres* (sarcostyles) in which fibrillae are absent. This will become clearer when we have considered the development of the imaginal thoracic muscles.

The great thoracic muscles of *Nasonia* are in the form of five pairs of longitudinal muscles, lying one above the other, and occupying the greater part of the thorax. Anteriorly they are inserted upon the ingrown extremity of the mesothorax, while behind they are attached to more or less strongly developed phragmas in the region of the metathorax and the propodeum. There are, besides these, five pairs of sternodorsales, attached to the more anterior portion of the mesothorax above, while below they are inserted close to the origin of the legs. The muscles which move the wings have, therefore, no direct communication with these; their action merely causes changes in the shape of the thorax, changes which alter the disposition of certain prominences and depressions on the thorax at the wing insertion, into which fit other depressions and projections from the base of the wing. A discussion of the mechanism of flight is beyond the scope of this paper.

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(5) A difference between these fibrillae and those of ordinary muscles was indeed considered in Schäfer's original paper (1891), and they were referred to as *sarcostyles*.

The development of these muscles begins in the larva at about the time of defaecation. An examination of even the earliest larvae will reveal scattered cells, the myoblasts of Pérez lying near the muscles, but remaining during larval life in an embryonic condition. They are not unlike leucocytes in appearance; but they are smaller, and do not show protoplasmic vacuolation, which is so frequently seen in the former.

But at the time of defaecation the longitudinal thoracic muscles show distinct indication of degeneration. Sometimes the striations merely become ill-defined. At other times the muscle substance undergoes a total disintegration, breaking down into a granular fluid which remains within the unruptured sarcolemma. This condition is especially well seen in the larva four hours later.

But while the majority of larval muscles disintegrate at a later stage, under the phagocytic action, apparently, of the leucocytes, a certain number of dorsally situated thoracic muscles—three, or sometimes four pairs—become enveloped by the myoblasts, which shortly before this have become very active.

Sometimes the myoblasts begin to spread over the muscles while these are almost normal in appearance (fig. 113); but at other times advanced degeneration is very apparent.

The proliferation of myoblasts, always by mitosis, is most marked at the metathoracic and the rear of the mesothoracic segment; from here the myoblasts extend forwards in a pair of great columns partly upon, partly independently of the larval muscles, drawing the neighbouring longitudinal muscles together as they advance (fig. 128); in the larva at the end of the period of defaecation they have extended right along the mesothoracic muscles (fig. 112), while the myoblasts at this stage are beginning to extend along the prothoracic muscles, which have almost retained their normal appearance (figs. 113, 129). Three or four of the dorsal pairs of longitudinal muscles of the prothorax and mesothorax are therefore concerned indirectly in the reformation of the longitudinal muscles of the thorax of the imago

The myoblasts divide mitotically (fig. 112); they are rounded ovoid or hexagonal cells with large "vesicular" nuclei. They measure 5½μ to 6μ in width, and have not appreciably altered in size throughout larval life

The myoblasts several hours later begin to penetrate the tough sarcolemma and work their way into the degenerate muscle substance (fig. 129); others follow, and in the larva eight hours after defaecation the whole muscle becomes riddled with myoblasts, all nourishing themselves, apparently, on the disintegrated larval muscle. They never lose their cytoplasm, such as Pérez describes in *Calliphora*

Any leucocytes which may be close by gorge themselves upon the dead muscle (fig. 129), but the myoblasts seem to proliferate so rapidly that before the few leucocytes, which may be present, have had time to depart they become entangled in the mass of myoblasts, and rapidly degenerate there (fig. 128) They are frequently seen in the early pupa —long after the last remnants of the larval muscles have disappeared—as spherical bodies, a little larger than the myoblasts, in which several large heavily staining globules are present (y in fig 135), and in which the leucocyte nucleus may still sometimes be observed. The presence of the embryonic cells appears to bring about their precocious disintegration. It is these disintegrating leucocytes, I believe, that Pérez has taken for the nuclei of the larval muscles, undergoing "chromatolitic disintegration." In *Nasonia* their nature is unmistakable; they do not become apparent till about sixteen hours after the larval muscles have disappeared.

Meanwhile the myoblasts have absorbed more and more of the larval muscles, and so extraordinarily rapid is the process that in the larva twelve hours after defaecation no trace of the larval muscles remains; in their place there occurs now a pair of bands of myoblasts lying some distance below the integument, on either side of the midline (figs. 130, 132). The two columns of myoblasts are at first unexpectedly small, measuring only 55μ in breadth, 14 to 15μ in thickness; they extend from the rear of the mesothoracic segment to a considerable distance into what was the prothoracic segment of the larva.

But already before the end of larval life a series of remarkable processes begins, which transforms these two strips of embryonic cells into the five pairs of great longitudinal thoracic muscles of the imago. In the larva, shortly before pupation, certain of the cells of these two myoblastic bands arrange themselves in the form of five columns of cells, each four cells in thickness. This condition of the bands is seen in fig. 131. The cells now appear to lose their inner walls so that five syncytial columns are produced, on the periphery of which the nuclei are disposed; other cells become incorporated later (see fig. 134). To these columns other myoblasts now apply themselves; these, however, do not become merged into the syncytium On the contrary, retaining their cell walls, they may be observed to give off at either end a process (fig. 139). These processes grow right along the syncytial mass and are the embryonic sarcostyles of which the adult muscle contains so many. Shortly after the process can be first observed the five syncytial columns begin to show a very distinct fibrillated appearance, as more and more myoblasts, applying themselves to the columns, send their fibre-like extensions into them

The process takes place with considerable rapidity, and already in the pupa four hours old the myoblast bands of the late larva now consist each of five columns of fibres (sarcostyles), surrounding each of which is the layer of cells from each of which a single fibre has been formed (fig. 134)

Between the myoblasts in the early pupa curious heavily staining rod-like structures may be observed (x in fig. 135). I am unable to say what their significance is

The myoblast cells continue to multiply in karyokinesis, and the strips grow considerably in breadth and thickness.

Then, in the pupa about twelve hours of age, the two bands at last split up into their five parts, and these are the rudiments of the great longitudinal thoracic muscles (wing muscles) of the imago. Each muscle consists, at this stage, of a great number (between 800 and 900) of fibres, while an actual count of the myoblasts surrounding it, really quite a simple procedure, showed, in the same muscle, 871 of these to be present. This fact, together with the observation of their mode of development, can leave no doubt that the muscle is built up of great numbers of fibres, each developed from one cell, and not of innumerable fibrillae, as is usually supposed. Between the fibres lies the interstitial substance, formed, it would seem, from the five syncytial columns of the early myoblastic bands.

In the thirty-six hour pupa the muscle is still in almost the same condition as that just described. The cells have now, however, lost most of their walls, and, their outer walls alone persisting, these form a structure which is comparable with the sarcolemma of other types of muscle. So far as I could observe, the connection between the nuclei and sarcostyles, which must once have existed, disappears entirely, so that from now on each muscle is one great syncytial mass, corresponding at first sight to an ordinary muscle in constitution, but built up, in reality, in an entirely different manner; it is a muscle built up of numerous fibres, and not a fibre which consists of many fibrillae.

In the thirty-six hour pupa a very curious thing is now seen, the interpretation of which is difficult; each muscle now presents a very faint striation, the striations being again in the form of a double spiral. The striations never become chromatic, as they usually do; nor do they correspond to the striations that develop later in the individual fibres. It will be seen later, when the muscle insertions are described, that these muscles are already pulling on the body wall, somewhat as they do in adult life, and perhaps the spiral striations represent the direction of the strain within the muscle, just as they do in muscles in which they are fully differentiated; but since the "pull" which these muscles exert at this time may be of only temporary duration, structural differentiation does not follow. It is interesting to note that the distance between successive spirals is almost exactly identical with what is seen in other muscles, *viz.*, about 8μ

Finally, in the pupa of the fourth day the individual fibres (sarcostyles) begin to show transverse striations (fig. 138); Krause's membranes, and the striations with Hensen's line between them, are all clearly seen; even the minute tubules which Schäfer describes appear to be visible; the structures, however, are so exceedingly minute that at present no further details can be given. The distance between successive Krause's membranes is about $2\frac{1}{2}\mu$, so that an undifferentiated spiral of the thirty-six hour pupa corresponds to about three "striations" of the component fibres.

Schäfer was unable to observe any clearly defined striations in the muscle as a whole; there is no doubt, however, that in *Nasonia* the striations of adjacent fibres are so disposed as to present a true striation in the muscle as a whole; nor is it surprising to find that these striations are disposed again in a double spiral.

Schäfer mentioned the occurrence of the nuclei within the muscle, *i.e.*, amongst the constituent fibres; there can be no doubt that in *Nasonia*, and also in *Calliphora*, according to the observations of Pérez, the nuclei surround the muscle.

The conclusions of Pérez, in regard to the development of the imaginal muscles, may be referred to here. This author described the myoblasts in *Calliphora* as spreading themselves over five pairs of thoracic muscles. The myoblasts, entering these, lose their cytoplasm, and apparently grow at the expense of the disintegrated muscle, nourishing themselves, perhaps, also upon the blood. At any rate, the syncytium formed from the myoblast grows, and then undergoes longitudinal fibrillation, the "fibrils" corresponding in no way with the individual myoblasts.

The fact that in *Nasonia* the number of fibres is approximately equal to that of the myoblasts, and that these can, though with difficulty, be observed to form each a fibril, renders the conclusions of Pérez in regard to *Calliphora* doubtful; it is also possible that the *five* pairs of larval muscles which persist and into which the myoblasts migrate, are in reality the syncytial columns observed in *Nasonia*, and that Pérez failed to observe the earlier state in which larval muscles were being overwhelmed. It is, of course, unsafe to argue by analogy, but the fact that Van Rees observed only *three* pairs of persisting muscles is significant.

During pupal life there is a considerable thickening of the five pairs of longitudinal wing muscles. In the late larva they represent a very narrow strip measuring 55μ in breadth, 14μ to 15μ in thickness. In the fresh pupa, when five columns of muscles have developed within these, they have become more prominent; but they do not yet form the predominating organ of the thorax. But in the twenty-one hour pupa, when they have broken up into five pairs of muscle columns, they begin to replace the fat-body, which has till now filled the greater part of the thorax, and growing larger and larger, displace this more and more, and with the vertical (dorso-sternal) muscles which have meanwhile been developing, occupy almost the whole of the cavity of the thorax.

The development of the dorso-sternal muscles is very similar to that of the longitudinal thoracic muscles, and need only be briefly referred to here. However, they serve to illustrate that the myoblasts may be quite independent of the degenerate muscles over which they are extending. In the imago five pairs of sterno-dorsales are present; three of these are formed by the extension of the myoblasts over the three pairs of degenerate vertical (oblique) muscles of the three thoracic segments of the larva; but the absence of sufficient larval muscles does not prevent the other two pairs from developing (the muscles of the propodeum play no part in the process, but degenerate in the same curious way as do the other vertical abdominal muscles). They simply grow as two pairs of vertical cell columns, quite independently of any larval muscle. Within each, as also in the other three developing sterno-dorsales after the larval muscle has finally been absorbed, a single columnar syncytium (not five, as occurs in the longitudinal muscles) is formed by the fusion of a column of cells. This syncytium remains as the "sarcoplasm" of the future muscle. The other myoblasts then, applying themselves to this column, form each a longitudinal sarcostyle which, growing along the muscle, eventually becomes inserted by its two extremities upon the dorsal and ventral walls of the thorax Striations, similar to those observed in the longitudinal muscles, occur on the fourth day.

So far as I could observe, the connection between the sarcostyles and their nuclei does not persist. The outer walls of myoblasts remain as the sarcolemma.

(8) *Intestinal Muscles.*

These are weakly developed; they will be referred to more conveniently in connection with the intestine.

(9) *The Muscle Insertions.*

These are entirely ectodermal cells, which during development force aside the underlying somatopleure and communicate with the developing muscles.

Sometimes the process is quite simple The terminal myoblasts come into communication with adjacent integumental cells which now support the muscles. Frequently these cells chitinise entirely, or only partly, so that the muscle may become inserted directly on the hard chitinous walls of the insect.

Frequently the adjacent integumental cells elongate greatly and actively extend towards the developing muscles. This may, as we have seen, give rise to the remarkable splitting up of cell columns into individual muscles, such as occurs in the head muscles, leg muscles, and muscles of the ovipositor, and there can be no doubt that the integumental cells are the active agents which bring this process about. In the case of the dilators of the pharynx the cells of the muscle insertions are formed from a much more limited area. They have the same elongated appearance as have the other head-muscle insertions; but there is no lateral pull as these processes retract again, and the muscle constituents are not pulled apart. It follows, therefore, that each pharyngeal dilator muscle is the equivalent of a whole group of head or leg muscles, which have all originated by the longitudinal splitting of a single column.

The insertions of the great thoracic muscles are especially interesting. The myoblasts at the extremities of the muscle columns approach close to the integument (fig. 135). The integumental cells begin to divide, in the fresh pupa, transversely to their length; division is not complete; on the other hand, the cells elongate remarkably, producing long threads, as much as 75μ in length, and consisting each of two or three cells joined one behind the other (fig. 136) These threads have become inserted into the syncytial columns of the developing wing muscles, and as they lengthen, the muscle bands contracting a little, become suspended in the upper part of the thorax.

Meanwhile in the newly formed pupa, the ectodermal cells of the mid-dorsal region of the propodeal segments elongate and grow forwards Passing underneath the more anterior muscle insertions of the metathoracic integument they extend forwards and penetrate the muscle column At the anterior end of the muscle columns more distant integumental cells likewise communicate with the developing mass of myoblasts, so that we get a condition not unlike what has been observed in the head and leg muscles; the insertion cells from a considerable area all converge upon the great muscle band. The result when the insertion cells contract is the same as what occurs in these other muscles. The two bands are pulled apart into their five constituent columns, and these on differentiating form the longitudinal thoracic muscles of the adult.

Contractions of the "suspension threads" is preceded by a longitudinal splitting of them, and each thread is now a unicellular structure (fig. 137).

The sarcostyles, as they develop within these minute columns, communicate several with one thread. The threads in the twenty-four hour pupa then begin to contract. The muscles become stretched and at the same time the walls of the propodeum and mesothorax become drawn closer together; in this way the arched thorax of the imago is formed.

The insertion cells meanwhile have secreted at their exterior, the cuticle of the integument, but they do not undergo complete chitinisation (fig. 137a). On the contrary, their more internal parts remain protoplasmic, and split up into a number of fibrils, each communicating now with a single sarcostyle. In this condition they are seen in the imago (fig. 138).

The Structure of the Adult Muscles.

From the above description it follows that the adult muscles are of several types. The simplest are the longitudinal abdominal muscles, formed by the fusion of succeeding myoblasts, in one line.

The dilators of the pharynx are more complex and correspond in reality to a number of these longitudinal muscles; they consist of several cell columns, and though in the adult they are not to be distinguished from the abdominal muscles, yet in their embryonic state the differences are obvious.

The individual muscles which constitute the leg muscles, antennal muscles, and the muscles of the mouth appendages and of the ovipositor, are similar to the longitudinal abdominals in structure, but their simplicity is a secondary condition—a whole group of them is morphologically the equivalent of a single pharyngeal dilator.

The contractile substance of all these muscles has assumed the same type of appearance, *viz.*, striations in the form of double spirals. In the pharyngeal dilators a certain amount of cytoplasm remains non-contractile; this contains the nuclei, sometimes as many as 15 in number, and is frequently in the form of a bulging mass on the side of the contractile syncytium (fig. 124). In the other muscles the nuclei are arranged in a row along the middle of the fibre

In their development the fibrillae are first formed; each of these then breaks up into successive "striations" as above described, adjacent striations disposing themselves in the form of a double spiral. The Krause's membranes are likewise *fibrillar* structures; but it is not impossible that adjacent Krause's membranes unite, though I have never been able to see clear instances of this fusion. It is interesting to note, however, that *artificial breaks generally occur right across a fibre along a series of adjacent Krause's membranes*, indicating that there is at least some coherence between adjacent fibrillae.

In all cases, the outer cell walls of the syncytium remain as the sarcolemma of the muscle

But the most interesting of all the muscles are the great vertical and horizontal thoracic muscles, and nothing like them seems to occur elsewhere among contractile tissues; they serve, indeed, as a remarkable instance of a great number of cells co-operating in different ways to form one highly efficient organ. The original syncytial mass forms what corresponds to the sarcoplasm of other muscles, while the contracting fibres (sarcostyles), devoid, as they are, of fibrillae, correspond to the fibrillae of intracellular structures It is interesting to note that the striations of adjacent sarcostyles are likewise disposed in the form of double spirals in the "muscle" as a whole, and it is particularly suggestive to note, that in this case, where the analogy is otherwise so extraordinarily close, no connection exists between adjacent "Krause's membranes." Even the sarcolemma of other muscles is represented, and it would be difficult to observe, anywhere, a more beautiful instance of a histogenetic convergence—of the development of similar structures from embryologically quite distinct elements

THE INTESTINE AND RELATED STRUCTURES.

It will be most convenient to consider these organs under the following headings:—(1) The anatomy and structure of the adult intestine; (2) the anatomy of the larval intestine, (3) the changes which go in the intestine during larval and pupal life, and which convert it into that of the imago. This will be described under several headings, *viz.*:—*(a)* The foregut; *(b)* the midgut; *(c)* the hindgut. It will then be necessary to consider certain closely related structures, *viz.*:—(4) The salivary glands, and (5) the malpighian tubules.

(1) *The Anatomy and Structure of the Intestine of the Adult.*

The *mouth* faces downwards and backwards in the position in which the head is usually held. This opens into a narrow high *buccal cavity* continuous above with a dilated pharynx, which opens into the *oesophagus*, a long very narrow tube, which passes forwards, then backwards through the circumoesophageal nerve ring, and enters the thorax Here it becomes even narrower, and passing through the thorax and propodeum as a very fine tube, enters the abdomen, where it forms a great dilatation, with fine papery, usually collapsed walls—the crop

The *crop* occupies only a small anterior part of the abdomen. Behind, it partly envelops and communicates with a very short *gizzard*, which in turn opens into a small drum-shaped chamber, considerably shorter than the gizzard. Behind this chamber lies the great *stomach*, occupying about one-third the volume of the abdomen, and between the two is a structure, formed by the slight projection of the chamber into the stomach, which evidently acts as a valve, to prevent any forward move of the contents of the stomach. The stomach is the true midgut, being endodermal in origin. All the structures preceding it constitute the foregut, and are, as will be seen, ectodermal in origin. Behind, the stomach is continuous with the hindgut, also ectodermal in origin

The hindgut is composed of two parts, an anterior portion, the small intestine, and a terminal portion, the rectum, which opens in the last segment by a small anus (fig. 22). The small intestine does not, however, open into the termination of the stomach; it communicates with that organ by a small aperture situated on its ventral side about one-quarter the length of the stomach from its posterior extremity. The small intestine then passes forwards half-way along the abdomen, then gradually bending backwards passes as a long tube into the rectum. The small intestine is about as wide as the gizzard, but in the region of its junction with the stomach it is considerably dilated.

The *rectum* is a short spacious chamber. Into it project, from its anterior walls, a single pair of remarkable organs, the rectal glands (figs. 22, 164). Behind, the chamber narrows, and opens by a short duct to the exterior.

Two structures must be considered in connection with the intestine: the salivary glands and the malpighian tubes.

The *salivary gland* is in the form of a single rounded clump of cells, lying in the postero-ventral region of the head, in the midline. It opens by a single duct into the buccal cavity. The salivary duct, however, extends far past the salivary glands; it travels upwards, along the posterior portion of the head, and ends blindly, after making a few irregular turns in the anterior portion of the thorax dorsal to the intestine. This distal prolongation must evidently serve as a salivary receptacle, and itself also contains some gland cells.

The *malpighian tubes* are in the form of eight slender thread-like structures bending in various directions and all opening into the anterior part of the small intestine, close to its opening into the stomach.

The minute structure of these parts varies considerably. The buccal cavity is lined internally by chitin which develops numerous thorn-like bristles, all projecting forwards. The pharynx is a great dilated portion of this buccal cavity. Its walls consist of a single layer of cubical epithelial cells, larger behind than in front. The pharynx, as well as all the succeeding portion of the foregut, is lined with a thin chitin sheath (fig. 124).

The epithelium of the oesophagus consists in the head-and-"neck" region of more flattened cells; in the ventral portion of the oesophagus before it enters the "neck" there is a thickening of this epithelium; and within the thickening lies a prominent chitinous bar, terminating in front in the region of the circumoesophageal connectives, and connected behind, by two very short chitin pieces, with the rear of the head. The remainder of the oesophagus is a simple fine hair-like tube which traverses the thorax close above the nerve cord, and enters the crop, within the abdomen. Its walls consist of extremely minute delicate spindle-shaped cells, with their long axes arranged longitudinally (fig. 158). Only with the greatest difficulty can nucleus and cytoplasm be observed. Internally it is lined by an extremely delicate chitin sheath.

In this portion of the oesophagus muscles are absent; but in the pharynx and the anterior part of the oesophagus these are well developed (fig. 124). There are the great pharyngeal dilator muscles, whose structure and development are described in connection with the general muscular system. They are attached by one end to the front walls of the head, and behind are inserted upon the epithelium of the front walls of the pharynx. Their contraction serves to dilate the pharynx.

Attached to the hind wall are a number of other less powerful muscles, which pass upwards and backwards and are inserted upon the epithelium of the chitinous thickening on the lower side of the oesophagus, above described.

Besides these muscles there are a number of others, much shorter than these, which are distributed longitudinally and circularly on the intestine. The longitudinal muscles are long spindle-shaped structures forming three or four layers on the front of the pharynx; on the oesophagus they are much more scanty. The circular muscles are arranged on the pharynx in thick bundles, lying outside the longitudinal muscles, each bundle being inserted upon the two lateral walls of the pharynx, which they partly enclose like a crescent. The circular muscles of the oesophagus are thin plates, not arranged in thickened bundles.

These bundles are all of the "striated" type. The oesophageal muscles appear to be unicellular. The longitudinal muscles of the pharynx are composed of five to six cells, fused into a syncytium.

The crop is a curious structure (fig. 159); its walls consist of very flat paper-like cells, in which cytoplasm is very much reduced. They closely resemble the cells of the wing epithelium before this straightens out on emergence, but always retain their nucleus and a very small amount of cytoplasm. Within their walls lie very fine muscles, which also serve to connect them with the crop.

These muscles are of a type which has not, so far as I am aware, been observed hitherto (fig. 125). They contain a small nucleus, which lies as a thickening on the fine hair-like muscle. But the muscle itself is not of the usual compact type, but possesses several branches, which may run in various directions; each branch represents one, or, at any rate, a very small number of fibrillae, and presents the usual striations. The fibrillae are too limited in number, however, for the striations to be able to dispose themselves in spirals, and for once it is possible to speak of true transverse striation.

The gizzard, on the other hand, is a very powerful organ. It measures only 70μ in length, 40μ in thickness. In shape it is roughly prismatic, and is triangular in section. Its walls consist of three thickened epithelial plates (fig. 160), each bent slightly inwards along its longitudinal median axis. The three plates are lined internally by a very tough but elastic chitin plate, which envelops them closely. The thickened epithelia do not meet along the three angles of the prism, and the intestinal epithelium here is much thinner. The thick chitin plates are likewise absent here.

Two sets of muscles are present There is an inner circular which connects the two longitudinal edges of each plate. A pull on them will evidently increase the angle at which the plate is bent upon its longitudinal axis. Outside the circular muscle layer lies a number of longitudinal fibres. All are striated.

The gizzard is then seen to be a very ingenious contrivance. In section its lumen is triradiate. A contraction of the circular muscles causes increased bending of the three chitin plates, and they move towards each other and tend to close up the lumen. The resulting organ ought therefore to prove a very efficient masticatory structure for an insect in which feeding is so reduced as in chalcid wasps.

The drum-shaped chamber immediately behind the gizzard is smaller than the latter. Its walls are composed of minute cells; these form a thickening several cells deep which projects into the stomach and forms the valve referred to above.

The epithelial cells of the great stomach are large and "brick-shaped" in appearance, measuring as long as 23μ. The cytoplasm is granular and vacuolated; the nucleus very large and faintly granulated. A great nucleolus may occasionally be present. A distinct cuticular lining is absent.

The small intestine (fig. 167) is lined by a single layer of irregular elongated columnar cells, each with a very large nucleus, and occasionally a great nucleolus; in places its epithelium is very irregular, and the chitinous lining formed within it presents these same irregularities. The irregularity evidently allows of greater distension. There is in places a highly developed coat of thick circular muscle fibres; longitudinal fibres are also present, being long and spindle-shaped and presenting a thickened nuclear swelling at their middle. The fibres are, as usual, striated.

The epithelium of the dilated rectum (fig. 168) consists of very large, rather flattened cells, frequently presenting a great nucleolus. The usual chitin lining is present. The very powerful muscle coating is in the form of a single layer of broad, flattened, contractile plates presenting the usual striations.

Projecting into the rectum from its anterior wall is a single pair of rectal glands (figs. 22, 164). Each is somewhat pyramidal in shape, and presents an outer syncytial region, covering an inner medullary region in which cell boundaries are sometimes just visible. The development of the organ, which will be considered later, shows that the outer cortex is merely the fused outer ends of the large cells which form the medulla and which sometimes lose their individuality. Nuclei do not, therefore, occur in the outer zone, but its distinctness, especially in immature stages, is very obvious. The cytoplasm of the cells is granular. The nuclei are large and granular and have a gigantic nucleolus. At the base of the pyramidal mass is a cavity, which is continued as a narrow duct upwards through the whole organ. The cavity does not appear to open into the body cavity; on the contrary, below it the lining of the rectum undergoes a special chitinisation. Through this chitin piece passes a large tracheole, which runs through into the rectal gland and there terminates. At the base of the pyramid are a number of curious cells; each is a hair-like filament, with a nuclear thickening either at its base or elsewhere along it, and these filaments stretch from one side right across the basal cavity towards the other (figs. 164, 165).

What the function of these extraordinary organs is I am quite unable to say. Lowne, searching for excretory organs in *Calliphora*, after denying the excretory function of the malpighian tubules, ascribed this function, without any definite reason, to the rectal glands. Hewitt observed them in the house-fly undergoing rhythmical contractions; in that insect they communicate with the body cavity, and he likewise concluded that they were excretory organs. The only fact in favour of this view, however, is their curious position; but the development of such organs in an insect already well provided with excretory tubules, seems to contradict this view. In *Nasonia* the only communication with the body cavity that they *may* have is by means of the basal filamentous cells; but what their function is must remain, for the time, undecided. In most insects two pairs of rectal glands seem to be present.

The single *salivary gland* is composed of a relatively small number of thickened granular cells, with large granular nuclei. A few cells in the centre of the gland have a vacuolated or branched appearance, giving the interior of the gland a spongy structure. The gland lies in close contact with the great salivary duct, and the walls of this duct, in the neighbourhood of the gland, present the same vacuolated appearance as characterises the interior of the gland. The gland secretion evidently enters the duct by percolating through this spongy tissue.

In its other regions the duct is lined by flattened epithelial cells, which thicken near its opening. Here a number of muscles are attached, which are inserted at the other ends upon the walls of the head.

The duct is lined by a chitin sheath, which presents spiral ridges similar to those seen in tracheae.

The *malpighian tubes* (fig. 150) are eight thread-like cylindrical structures, each with a narrow flattened duct, the duct is formed essentially by the incomplete junction of embryonic cells in irregular pairs. Sometimes adjacent cells do not fuse completely and the canal in consequence extends between these also.

The cytoplasm of the cells is very clear and homogeneous but often exhibits very large vacuoles. The nuclei are large and granular and have one or two medium-sized nucleoli.

(2) *The Intestine of the first Larval Instar.*

In the larva there is a small *mouth* (fig. 1), the openings of the conical buccal cavity, which contains the minute sharp jaws (fig. 47). This leads behind into a long *oesophagus* (figs. 1, 140) which passes horizontally backwards through the circumoesophageal nerve ring, and opens in the third segment into a great sac-like dilatation, the midgut (figs. 2, 140). The latter is endodermal, the oesophagus ectodermal in origin The midgut occupies the greater part of the body extending backwards to the third last segment. Here it lies in close connection with the hindgut, but the two do not communicate till the time of defaecation, *i e.*, till about one day before pupation. The midgut, indeed, is simply a blindly ending sac (fig. 143), and it is not till the last day of larval life that the unabsorbed food is discharged.

From a portion of the oesophagus (foregut) the whole of the intestine of the imago as far back as the beginning of the stomach will develop during metamorphosis. From the great larval midgut the stomach of the imago is formed, while the small intestine and rectum are developed from the hindgut. The endodermal portion of the intestine is therefore much smaller in the adult than in the larval insect, and it is entirely from the ectoderm that the other structures—crop, gizzard, etc.—become developed.

It is curious to observe how highly differentiated the intestine of the imago is, in an insect which rarely feeds, while the larva, which does nothing but feed, must content itself with so simple a structure.

Opening into the base of the mouth is a median salivary duct, which soon divides into two parts. Each of these smaller ducts passes backwards and communicates with the two large *salivary glands* (fig. 142), which reach back to about the fourth body segment. The distal extremity is drawn out into a narrow prolongation of the main salivary gland.

Running along the sides of the midgut, and opening into it posteriorly, is a pair of long moniliform tubes, the haepatic caeca. A third such tube, shorter, however, than these, opens into the midgut behind, and passes backwards over the rectum (fig. 140). The two lateral caeca have been observed by various investigators in the larvae of chalcid wasps. The third median caecum has not, so far as I am aware, hitherto been described. But the interpretation which is always placed on them is quite erroneous. They are regarded as malpighian tubes, but have in reality an entirely different function. For this interpretation see, for example, M. Haviland (1920, 1921). They are digestive glands, and in both structure (as will be seen later) and embryonic development, differ entirely from true malpighian tubes. The latter are ectodermal in origin; the structures that occur in the larva of *Nasonia* are outgrowths from the *endodermal* midgut Furthermore, they have no opening to the exterior during larval life, and empty their secretions into the blindly-ending midgut.

The necessity for such large haepatic caeca is clear when we consider the rapidity of feeding during larval life; the salivary glands are quite unable to cope with so great a quantity of food, and well-developed haepatic caeca are but to be expected. The secretion is poured into the posterior part of the midgut, and the mixing with the engulfed food is the result of a remarkable forward peristalsis which can clearly be observed about once every fifteen to twenty seconds in the feeding larva. A peristaltic wave travels along, from behind, forwards, not only on the walls of the midgut, but also on the body surface itself, and this brings about a perfect churning of the contents of the great food sac.

When now we look for the true malpighian tubes, we find that they are absent, and that the larva is entirely devoid of excretory organs. And unless excretion occurs by the diffusion of ammonia through the integument, no excretory activity goes on during active larval life.

This fact, however, is less remarkable than it may at first sight appear to be. The larva is exceedingly sluggish, and is feeding upon food which has approximately the chemical composition of its own tissues. Practically the only energy expended is that which is needed in growth, and it is conceivable that the excretory products resulting from the necessary protein deaminisation accumulate in the blood during the five days of larval life. In the late larva numerous crystals, evidently excretory in nature, begin to accumulate within the fat-body, and these do not disappear from there till the malpighian tubules are already well developed. Their disappearance coincides at that period with the appearance of undoubted urates in large quantity in the intestine

The loss of nitrogen as diffusible ammonia must, of course, not be disregarded, but the fact that actual excretory organs are absent cannot be doubted.

It should be observed that this in no way supports the well-known statement of Lowne that the malpighian tubes of insects have a hepatic function. Urinary crystals often occur in immense numbers within the tubules of various insects, and their excretory function is established beyond doubt. Lowne, in searching for excretory organs, attributed this function to the rectal glands He also regarded the periodic moulting as aiding in nitrogen excretion. The chitinous cuticle, however, which is shed is chemically an amino-polysaccharide, and contains less nitrogen than does protein; if anything, its formation increases the proportion of nitrogen in the larva.

The histological differentiation of the various regions of of the larval intestine is not very marked in the first instar

The *buccal cavity* is lined by rather small clear cells, 6½μ in thickness, each with a large clear nucleus containing a large karyosome but no nucleolus. Internally the buccal cavity is lined by a thick chitinous sheath (fig. 47). On the dorsal side of the buccal cavity are a number of circular muscles—large unicellular spindle-shaped structures inserted by their two ends upon the two lateral walls of the buccal cavity. In the first instar no distinct striations are visible, but in later larval life these differentiate.

The *oesophagus*, which is lined by cuticle, is composed of a single layer of small cubical cells, presenting the usual undifferentiated appearance of the larval cells at this stage, *viz.*, clear cytoplasm, and a vesicular nucleus with a large karyosome. The oesophagus projects slightly into the great midgut, and this serves as a valve to prevent any regurgitation of food during forward peristalsis. The oesophageal epithelium, just in front of the great midgut, is several cells in thickness. The cells are slightly smaller than those found elsewhere in the oesophagus, but are otherwise indistinguishable from them. The slightly thickened ring which they form is the *imaginal disc of the oesophagus*, from which the greater part of the foregut of the imago as far back as the stomach will develop during pupal life.

The *midgut* is lined by what appears to be a very delicate cuticle. The epithelial cells lining it are much larger than those occurring elsewhere in the intestine. The great accumulation of food within the midgut soon stretches them (fig. 10), and already at the end of the first instar they are becoming flattened; they measure at this stage about 68μ in length (and breadth), 11μ in thickness. The cell cytoplasm is vacuolated and granular. The nucleus is large (17μ) and is very heavily granular.

At the base of many of these cells there is frequently to be observed a much smaller cell, spindle-shaped, about 17μ in length, 4μ in height (fig. 10). Each has a large clear nucleus and a distinct karyosome, and represents an undifferentiated non-functioning cell, which will become active during the defaecation period, and will form the great endodermal intestine of the early pupa. The anterior portion of this, as will be described later, will disintegrate, while the hinder will persist as the stomach of the imago. It is, therefore, possible to speak of these cells when they occur in the posterior region of the intestine as *imaginal stomach cells*: the more anterior ones cannot be thus described. I shall refer to them later as *replacing cells.*

External to the epithelium is a rough network of longitudinally and circularly disposed muscle fibres.

The *rectum* (figs. 143, 185) is a prominent ectodermal ingrowth through the anus—a true proctodaeum, but does not yet open into the midgut. It is a rounded tube, lined by chitin, with a columnar, or, in places, cubical epithelium. Surrounding it is a layer of circularly disposed, as yet unstriated, muscle fibres. The epithelial and muscular cells still retain the usual undifferentiated appearance of clear cytoplasm and large "vesicular" nulcei.

The cells at the anterior end of the proctodaeal invagination fit tightly against the rear of the midgut, and form a layer several cells in thickness (fig. 143). The cells here are slightly smaller than elsewhere and constitute the *imaginal disc of the hindgut*, from which the small intestine and rectum of the imago will later develop.

The *salivary glands*. These consist each of a large sac-like structure—the secreting portion, and a duct of medium length, the two ducts uniting before opening into the mouth. In the first instar the common duct is rather flat and strap-like; along its middle passes a prominent canal, lined by a chitinous spiral intima, which is shed and reformed at each moult. Further behind, the duct becomes circular in section, and is composed of very small cells with the usual "first-instar" appearance, *viz.*, large clear "vesicular" nucleus, with a big karyosome, and with clear hyaline cytoplasm. The glandular sac consists of about twelve very large, somewhat flattened cells, enclosing a large lumen. The cells are as much as 23μ in diameter and have large granular nuclei 11μ in diameter.

The *hepatic caeca* (fig. 10), which are usually falsely regarded as malpighian tubules, are composed of a number of very large rounded cells, arranged alternately in pairs, their union is such that a considerable space is left by the incomplete fusion of a cell with the one opposite it, while the fusion of cells with those behind them is always complete. The lumen is lined with myriads of minute cilia (figs. 10, 146), whose movement drives the secretion backwards (or forwards, in the third caecum) into the intestine. The individual cells measure about 17μ in diameter and have a remarkable resemblance to the cells of the fat-body. The nuclei are very large and heavily granular, and the cytoplasm faintly granular, and already at this early stage slightly vacuolated.

The hepatic caeca appear to be formed in the embryo as outgrowths from the midgut, this is indicated by the fact that in the first instar the third (posterior) caecum is present as a short, solid, robust projection from the rear of the midgut, and that it is only later that it acquires its ciliated lumen.

(3) *The Post-embryonic Development of the Intestine*

The feeding period of the larva *(i.e.*, about the first three days of larval life) is characterized by the completion of differentiation of the cells of the first instar, by a great growth in cell size, and by a corresponding total absence of cell division, except in the case of those cells which constituted the "imaginal tissues" of the larval intestine, *viz.*, *(a)* the oesophageal imaginal ring, surrounding the posterior part of the foregut; *(b)* the small "replacing cells," as I shall designate them here, which lay scattered about at the bases of the large cells of the midgut, and *(c)* the imaginal disc at the anterior extremity of the rectum

The visible differentiation is not very marked; it concerns mostly the intestinal muscle cells which, though already functioning, have not yet adopted a striated appearance; but before the end of the second instar this is always visible.

(A) *The Metamorphosis of the Foregut.*

During larval life there is a great increase in the size of the muscle and epithelial cells of the foregut; at each moult the cuticle is shed and secreted anew.

But shortly after feeding ceases the epithelial cells begin to degenerate. The nuclei are granular and greatly hypertrophied, and possess a large nucleolus, so characteristic of the degenerating cells of *Nasonia.* In the defaecating larva the cytoplasm undergoes granular degeneration; or, at other times, it breaks up into larger globules, which, breaking from the cells, float about in the blood and are there engulfed by any leucocytes which happen to be present, or, if left to themselves, dissolve in the blood.

These changes are accompanied by an active regeneration of the foregut (fig. 117). During larval life (though I cannot say definitely at which period of it) a proliferation of the cells of the oesophageal imaginal ring has occurred, and these, forsaking their ordinary cubical shape, elongate and become spindle-shaped (fig. 152). Continuing to divide mitotically they bulge outwards, and at the same time extend forwards, and in the defaecating larva are to be seen actively replacing the disintegrating larval cells. Although I did not observe them penetrating these cells, as in the case of the myoblasts extending over dead muscles, yet it seems probable that they actively absorb the products of disintegration and grow at their expense, so near do they lie to the dead larval cells.

The oesophageal epithelium is partly regenerated also from another centre, *viz.*, the integumentary imaginal discs of the first segment; and in the defaecating larva these embryonic cells are to be seen extending through the mouth inwards, between, or over the dead and disintegrating cells of the larval epithelium, while the proliferating cells of the oesophageal ring extend forwards to meet them (fig. 117). About four hours after defaecation the two have met.

Meanwhile there has begun a proliferation of certain myoblast cells, which lie during the whole larval life scattered about in the head in the neighbourhood of the mouth. these extend backwards as a loose column of very long spindle-shaped cells, drawn out in long thread-like processes at either end (fig. 117). They form the musculature of the anterior part of the oesophagus. Others are to be seen behind the oesophagus; the muscles which they form are differently disposed from those of the anterior side of the oesophagus, and will be considered later. The development of the great pharyngeal dilator muscles is considered in connection with the development of the general muscular system.

During the remainder of larval life the cells, occasionally still dividing, settle down, and growing in size, co-operate to form a single epithelium—that of the adult oesophagus. This development is accompanied by a great bending downwards and backwards of the head, as already described, and the result is a total change in the course taken by the oesophagus. It now passes not directly backwards, but first upwards and forwards actually, and only then begins gradually to bend backwards. Meanwhile the cells of the circumoesophageal imaginal ring have continued to proliferate, and in the fresh pupa form a great cone of cells, attached behind to the anterior end of the foregut, and ending, in front, just behind the brain (fig. 154). The structure is composed of two layers – an inner of long columnar cells, all tightly compressed and arranged radially around a very narrow central lumen. Outside this is a second layer one or more cells in thickness, the individual cells are much smaller here (fig. 153). From the great inner layer the succeeding portion of the intestine as far back as the gizzard is soon to develop.

The smaller outer layer has a much humbler future; when the cells of the great inner layer have migrated backwards (a process which commences several hours after pupation), the outer layer cells extend round to the lower side of the oesophagus and form a rather thick column there in front of the neck, but not extending as far downwards as the brain.

It is in connection with this structure that the developing myoblasts of the rear of the oesophagus now come; these cells, having united end to end during late larval life, now form several rows of cells, inserted behind all upon the sub-oesophageal cell column, and in front at various points on the rear of the oesophagus. Adjacent cell walls now break down, and each row forms a single multinucleated syncytium. During the third day of pupal life these syncytia develop spiral striations and form the post-oesophageal muscles of the imago. Meanwhile, the sub-oesophageal cell column, upon which the columns of myoblasts are all inserted, begins, in the thirty-six hour pupa, to chitinise internally. Chitinisation continues and the chitin rod fuses with two other very short processes which have grown out from the rear of the head, close to the neck. By this means, the musculature of the rear of the oesophagus obtains a very firm support.

Already in the fresh pupa, the myoblasts of the anterior part of the oesophagus have disposed themselves longitudinally or circularly in the position they are to occupy in the imago; several cells usually fuse to form small syncytia, and, undergoing the usual differentiation, form the striated muscles of the adult oesophagus.

It remains only to note that these changes are accompanied by a new secretion of chitinous cuticle within the lumen of the oesophagus, the old having been drawn out through the mouth at the pupal moult. The development of the rest of the foregut does not occur till a series of remarkable processes have taken place in the anterior half of the midgut; only then does the foregut extend backwards, and, occupying the place of the anterior half of the true (endodermal) midguts of the larva and early pupa, fuses with the posterior half, which remains as the stomach, being all that survives of the old midgut. The midgut will, therefore, most conveniently be considered first.

(B) *The Metamorphosis of the Midgut and the Development of the Post-oesophageal part of the Foregut.*

I have already described the midgut as composed of a single layer of large flattened cells, with smaller cells at their bases. As many of these smaller cells do not survive in the imago, I shall refer to them here as *replacing cells.*

Neither larval nor replacing cells, so far as I can observe, proliferate during larval life. The larval cells grow enormously in size, and, through the pressure exerted upon them by the contents of the midgut, are seen, at the end of the third day, as great flat cells, with smaller replacing cells at their bases. But during the third day these replacing cells begin slowly to divide by mitosis, while the great larval cells remain inactive.

But at the end of the fourth day of larval life a great change begins. At about this time the rectal ingrowth at last fuses with the midgut; and this event is marked by the commencement of a series of contractions of the muscles of the intestine which gradually drives the undigested food, which has accumulated here during larval life, to the exterior. This is the defaecation period of the larva, and lasts from one to two hours. But it is apparently under the pressure exerted by the muscles that a remarkable process of disintegration of the epithelium of the larval midgut begins. The disappearance of the faecal material allows the cells to return to the cubical conditions in which they existed in the new-born larva.

In the cytoplasm of the midgut epithelial cells before defaecation, vacuoles were already becoming numerous; usually, however, it was quite granular and showed obvious signs of degeneration. Not only had the cells grown greatly, but the nuclei had greatly hypertrophied, and were to be seen as long, irregular, faintly granular, chromatin masses, devoid of nucleoli. When the cells contract these long nuclei become bent; and a section presents the curious but false appearance of large multinucleated cells.

But at defaecation the vacuolation becomes very much more marked (fig. 144); the vacuoles consist perhaps of fatty material and occasionally contain feebly staining grains. They are suspended in a very faintly granular "spongioplasm." As the pressure exerted by the muscles increases the cells begin to project irregularly into the intestinal lumen; and then a very remarkable thing is to be observed. The spongioplasm, together at times with the vacuoles, begins to ooze out through the cell membrane, and hangs as one or more large drops, suspended in the intestine from the degenerating cells (fig. 144). The process commences in the anterior part of the midgut, but soon extends right along it, as the faecal contents are gradually voided. The products of degeneration are themselves, however, retained in the lumen of the intestine. There they granulate and are seen sometimes as little balls of grains, at other times as a fine dust. Eventually the whole of the cytoplasm is cast into the now very contracted lumen of the midgut; and all that remains is the cell membrane containing a very degenerate looking clump of chromatin grains. But these are soon added to the mass of *débris* which now consists of fine grains, of small clusters of grains, of fragments of nuclei, and of the contracted walls of the dead cells; all forming a dark mass that now occupies the lumen of the intestine. In the larva eight hours after defaecation these changes are complete, and all the old larval epithelium has disappeared, with the exception of a narrow strip of dead cells running along either side of the intestine from one end to the other (fig. 146). The temporary retention of these cells is an extraordinary adaptation for bringing about the destruction of the hepatic caeca; their fate will be described later.

It is necessary to return now to the replacing cells. In the defaecating larva these cells have begun to proliferate by mitosis, and by the time the larval cells have lost most of their cytoplasm (*i.e.*, about four hours after defaecation), these have formed a completely new epithelium, closely surrounding the degenerate larval epithelium. This gives the intestine the false appearance of having a functional two-layered epithelium (fig. 145). But as the larval epithelium disappears more and more, the cells of the new epithelium increase in size, and in the eight-hour pupa alone persist, except for the two thick bands of dead cells on either side of the intestine, close beside the great hepatic caeca.

But shortly after this an extraordinary thing is to be observed. The cells of the renovated epithelium, growing in size, begin to push the two longitudinal columns of dead cells into the lumen of the intestine. To each of these columns —the sole remains of the epithelium of the larval midgut— the hepatic caeca, which have now grown 70μ in thickness, with great granular nuclei 13μ in diameter, are connected along their length by means of the fine membranous peritoneum (fig. 146). And as the growing epithelium forces these remains of the old intestine into the lumen, the hepatic caeca are pulled bodily in with them along the whole length of the intestine. In the larva sixteen hours after defaecation the hepatic caeca are being slowly but surely engulfed (figs. 147, 148), and six hours later have entirely vanished. To the *débris* within the alimentary canal is also added the third (posterior) caecum. This becomes drawn into the midgut in a very similar manner; dead larval epithelial cells at its base fail to disintegrate, and the surrounding cells of the new epithelium pushing these cells inwards cause the third caecum to be slowly drawn into the lumen where it disintegrates along with the other disorganized tissues.

Even before being absorbed the hepatic caeca show signs of degeneration, small globules of cytoplasm being thrown into their lumen.

The function of the renovated epithelium appears to be to absorb this *débris* (fig. 154), perhaps after it has been digested by the enzymes liberated from the disintegrated hepatic caeca. At any rate, a marked absorption of the *débris* commences in the fresh pupa. Muscular contractions in this region later drive part of the contents into the posterior portion of the gut, and here the apparently indigestible cell membranes of the old larval epithelium accumulate, and may persist in small quantity till the emergence of the wasp, when they are voided through the anus. But the greater part of the fine granular *débris* soon disappears.

Meanwhile in the late hours of larval life a few cells from the rear of the great conical circumoesophageal imaginal ring have grown in as a short solid mass of cells into the anterior end of the midgut (figs. 153, 154). They push the adjacent intestinal cells along with them and the two cooperate to form a temporary obstruction which prevents the *débris* within the intestine (especially when the muscles of the anterior portion contract) from entering the foregut. This "plug" does not, however, develop till shortly before pupation, and closure of the anterior region of the midgut during the period which intervenes between defaecation and this, is brought about by a muscular contraction here, which causes considerable folding of the epithelium, and a consequent closure of the passage. The general nature of the regenerated midgut is seen in fig. 154.

The cells of the newly formed epithelium, which have now attained quite a large size, having performed their function, now begin to disintegrate, and for a second time an extensive destruction of the midgut occurs. The process commences shortly after pupation, but is quite different from what occurred in the larval midgut. The whole epithelium of the anterior half of the midgut begins to break up into a mass of rough granules. The muscle fibres of the intestine, losing their striations, join in the general process of disintegration, and what was a few hours earlier an actively functioning tissue, is now a loose accumulation of granular *débris*. This time, however, the leucocytes act, and swarming into the disintegrated mass rapidly absorb it (fig. 153); after six hours not a trace of the temporary midgut remains. The small conical projection of the foregut takes part in the general destruction, and nothing of the renovated midgut remains except the posterior half, in which no disintegration whatever has occurred. This portion remains with but little change as the stomach of the adult insect. Its structure has been referred to already.

But before the anterior half of the midgut has had time to disappear entirely, the cells of the inner layer of the great conical circumoesophageal imaginal ring have sprung into activity; they grow rapidly, moving evidently by amoeboid action, along the pathway afforded by the disintegrating mass, and, extending right through the thorax and anterior abdominal segments, at last reach, in the eight-hour pupa, the anterior end of the hinder half of the midgut which has survived these violent scenes unchanged. From this newly formed structure the post-oesophageal part of the foregut soon begins to differentiate.

In the thoracic and propodeal regions it is formed, and persists, as a very fine, almost capillary, tube, 8μ to 10μ in diameter (*cf.* fig. 156). The cells, which are at first irregular and embryonic in appearance, soon elongate, grow spindle-shaped, and dispose themselves longitudinally. They seem to lose part of their cytoplasm later in pupal life, and in the adult insect appear almost devoid of it.

But the abdominal portion of the foregut undergoes a much more complex differentiation. In the eight-hours pupa its posterior extremity is seen as a thick-walled, somewhat conical and slightly dilated chamber (fig. 155). This will develop into the crop, the gizzard, and the "drum-shaped" chamber. Its epithelium is composed of long columnar cells, which gradually merge, in the region of the petiole, into those of the narrow capillary portion. Surrounding the structure is already to be seen a number of cells forming a distinct layer of myoblasts. The lumen does not yet communicate with that of the stomach, but ends blindly. The hinder part of this lumen is rather constricted and will form the cavity of the gizzard and "drum-shaped" chamber. The more anterior part is more widely dilated. Here the crop will develop.

The development of the crop is very curious. The epithelial cells entirely lose their columnar character; they flatten out more and more, and in the pupa one day old have become highly wrinkled. The flattening continues, and instead of a small conical chamber with very thick walls there is formed a highly distensible collapsed bag with very thin paper-like walls (fig. 156). The cell differentiation closely resembles that observed in the cells of the differentiating wing epithelium.

The gizzard rapidly differentiates. Already at the end of the first day its lumen has become triradiate; this is brought about by the epithelium arranging itself in the form of three short longitudinal plates, bent along their longitudinal midline. The epithelial cells are still embryonic in appearance. The myoblasts have already arranged themselves in their definite positions. Their future development is exactly the same as occurs in the case of other muscles and need be referred to no more

In the thirty-six hour pupa the three bent epithelial plates are beginning to secrete chitin on their inner walls; and the posterior portion, where chitinisation does not occur, is observed to be marked off as a small rounded chamber, into which a short "filament" projects from the hinder wall (fig. 156).

During the next day the chitinisation strengthens, and with the appearance of the muscle striations the gizzard attains its adult proportions.

Cell proliferation of the drum-shaped chamber occurs also at this time, and at last a communication between foregut and stomach is established (fig. 157).

(C) *The Metamorphosis of the Hindgut.*

The walls of the rectum undergo the same changes during larval life as occur elsewhere in the larva, *i.e.*, there is a growth in cell size, in the absence of cell division; the muscle fibres during the second instar gradually acquire striation.

But about half a day after feeding ceases, the cells of the anterior end of the rectum, which constitute the imaginal disc, become active, and proliferating greatly at last bring about a junction of the cavities of the midgut and hindgut. The actual opening is large and funnel-shaped. Not till this time, therefore, does the embryonic proctodaeal invagination open into the archenteron; usually, in other insects, this occurs during embryonic life.

This event is quickly followed by muscular contractions in the midgut, and two hours later the whole of the faecal matter, which has accumulated during the three days of active feeding, is voided. The rectal musculature takes part in the process, only a small part of the faecal matter at a time is passed into the rectum, and this, under the pressure of the muscular walls, is rounded off into a little pellet, which is forced slowly along the rectum.

Meanwhile the epithelial cells have begun to degenerate. The nuclei are large and granular, the karyosomes having scattered their material through the nucleoplasm as this gradually hypertrophied. The cytoplasm then undergoes granular degeneration. In the defaecating larva these granules cluster together in little balls and breaking through the cell membrane float about in the blood stream, where they may become engulfed by phagocytes; or, if these are not present at the time, simply dissolve in the blood plasma. At other times the cytoplasm becomes broken up into a number of larger hyaline globules, like those of the integumental cells. They share the same fate as do the balls of granules.

Meanwhile, the cells of the rectal imaginal ring grow backwards as well as forwards, and as the rectal epithelium disintegrates they rapidly replace it. Already in the defaecating larva the epithelium of the anterior quarter of the rectum is composed entirely of embryonic cells, and these, dividing mitotically, are actively growing backwards, replacing the epithelial cells as these disintegrate more and more. A few hours later the whole larval epithelium has disappeared, and a loose layer of spindle-shaped embryonic cells has replaced it. The muscle layer does not disappear till a few hours after pupation.

The cells of the renovated epithelium now consolidate their position. In the larva some eight hours before pupation a cuticle is being secreted between the old cuticle and the epithelium, and when the larva moults the old cuticle of the last larval instar is drawn out through the anus.

In the fresh pupa myoblast cells, which were present in only small numbers during larval life, having proliferated considerably during the last twenty-four hours, now form a distinct layer outside the rectum, and it is not till several hours later that the old larval muscles begin to disintegrate and become phagocytised.

The renovated hindgut epithelium now begins to differentiate into two regions; the small spacious rectum behind and the small intestine in front.

The cells in the mid-region of the hindgut are, in the early pupa, in a state of rapid proliferation, and this, continuing into the next day, produces a considerable bending of the anterior region. That portion behind the centre of proliferation is the rectum; the portion anterior to it, the small intestine. The amount of this proliferation seems to vary considerably, so that, while the intestine is sometimes quite bent upon itself, at other times the bending is far less marked.

Having arrived at its maximum size, the cells of the small intestine begin to differentiate; but the differentiation never becomes very marked, and the epithelium remains as a single layer of elongated loosely arranged cells, on whose surface an equally irregular chitin sheath is secreted. The organ is evidently capable of considerable stretching.

Already in the fresh pupa the rectal region of the hindgut is distinguishable from the small intestine by the "spindle shape" of its epithelial cells. The tube is already more distended than the anterior portion, but six hours later attains its adult proportions. It is not till six to eight hours after pupation that the larval muscles finally disappear by phagocytosis, after having undergone globular degeneration.

The adult muscles develop in the usual manner.

The Rectal Glands.

During the last hours of larval life the cells of the anterior region of the rectal portion of the hindgut begin to proliferate and grow in the form of two small clumps of elongated cells into the cavity of the enlarging rectum (fig. 161). These are the rudiments of the single pair of rectal glands, and have already attained to a considerable size in the fresh pupa.

The rectal glands grow considerably in size. The elongated cells dispose themselves in a single layer with their long axes vertical to the surface of the gland; the whole structure has, in the eight-hour pupa, a short cylindrical shape. It is solid except below, where there is a cavity lying loosely in which is a large number of much smaller cells. They are the elongated filamentous cells already described. A cuticle is in process of secretion. The rectal gland lies in close contact with the wall of the rectum from which it has been developed, and there appears to be no communication through it, between the cavity of the rectal gland and the haemocoele.

During the rest of the first day the rectal gland elongates considerably, by growth of its cells, not by their proliferation. The small basal cells now dispose themselves in a ring at the base of the gland; in the twenty-one hour pupa some have developed their remarkable filamentous structure; others are in process of dividing. This leaves the cavity, in which they lay, devoid of cells, and at this stage a canal, formed by the incomplete fusion of the bases of the large cells, is developed right along the axis of the gland, and opens below into the large basal chamber. The great elongated cells have meanwhile begun to fuse on their outer surface, and from now on the rectal gland may be divided into an outer syncytial cortical portion, surrounding an inner medullary region in which cell walls are still well marked. The cortical portion is formed by the fusion of the outer ends of the elongated cells, the medulla is the region which becomes differentiated by the failure of the cells to fuse here

In the thirty-six hour pupa the glands have grown to their maximum size. Cortex and medulla are very clearly seen (fig. 163). The central canal is prominent; the basal cells have differentiated into their adult filamentous condition. The cells of the rectum at the base of the two glands have proliferated a little to form two thickened pads; a trachea soon penetrates the rectal wall here. During the third day, the thickened pad begins to chitinise.

Even in the fifty-six hour pupa the medullary region is distinguishable, but from now on the syncytium becomes more and more developed, and in the mature organ no distinction can usually be drawn between medulla and cortex.

In the advanced pupa the large elongated cells begin to develop nucleoli of extraordinary dimensions (fig. 166) Sometimes they occupy nearly the whole nuclear space.

The Malpighian Tubes.

In the adult larva shortly after the cessation of feeding, the malpighian tubes become visible as small papillae on the anterior end of the hindgut (fig. 160). Here the cells of the imaginal ring have begun to develop, and it is not till this time that definite malpighian tubes can be observed.

The papillae begin to grow with extraordinary rapidity, and by the time the larva defeacates (*i.e.*, twelve hours later) they are visible as long thin threads (fig. 151), sometimes reaching almost to the dorsal body surface. From the first they have a narrow lumen. The walls are one cell in thickness; the cells are roughly cubical and fit loosely together. The tubes measure about 6μ in diameter.

The tubes continue to grow in length, but not in thickness. In the fresh pupa the cells, which had previously the usual embryonic features—large karyosome, "vesicular" nuclei, hyaline cytoplasm—now begin to show signs of differentiation. The nuclei become granular, and the cytoplasm becomes uniformly slightly vacuolated. Nucleoli are not yet present.

The tubes from now on grow mainly in thickness, and in the thirty-six hour pupa have attained their adult proportions. With the exception of an absence of nucleoli the cells are, to all visible appearances, in their adult condition.

The appearance of the malpighian tubes is followed shortly by the deposit of excretory material within the stomach (midgut). During larval life, as I have pointed out above, no removal of excretory substances appears to occur; towards the end of larval life, when the processes of growth necessitate a considerable deaminisation of the proteins of the disintegrating tissues, and *perhaps* of protein reserves within the fat-body, crystals, which are regarded as urates, accumulate in the fat-body and nucleoli of various tissue cells. On the other hand, a microscopic examination of the contents of the midgut of the larva shows no trace of these. But after the first day of pupal life small crystals begin to appear in the stomach; in the thirty-six hour pupa they increase in number and size; and from now on the stomach becomes a depositing place for the excreted urates and the undigested hulks of the old larval epithelial midgut cells.

In many instances (*e.g.*, the silkworm) the urates are to be observed within the malpighian tubes as minute crystals. In *Nasonia*, however, they do not crystallize out till reaching the stomach. Here some of the crystals actually are far wider than the lumina of the tubules, and have grown in size within the stomach.

At the time these crystals begin to appear in the intestine those of the fat-body and nucleoli disappear, and though the crystals in the two places have no resemblance to one another, yet it is probable that the two events are closely related. Pérez (1920) observed that the "pseudonuclei" of the large storage granules ("albuminoid grains") disappeared when the urates began to accumulate in the rectum of metamorphosing insects; and came to the same conclusion as that expressed above, basing his view on the experiments of Marchal, who was able to convert these "pseudonuclei" into crystals by treatment with acid.

Finally, when the wasp hatches, these excretory crystals and any other contents of the stomach are thrown out.

Crystals similar to these form the creamy or pink material excreted by insects shortly after emergence. They are especially well seen in the silkworm, where they can be gathered in considerable quantities. They give the murexide test for uric acid; a faint ammonia reaction can also be obtained with Nessler's solution.

The Salivary Glands.

The main changes undergone by the salivary glands during larval life are a great growth in the size of the constituent cells In the adult larva they are as much as 57μ in length, 28μ in breadth; they are highly vacuolated and have gigantic granular nuclei 30μ long, 17μ broad, and usually contain several small nucleoli.

The duct cells also grow largely in size, their spiral intima is shed and reformed at each larval moult.

While the glands do not disappear till early in the pupal period, the median duct is actively disintegrating already in the defaecating larva. The larval cells have met the same fate as those of the oesophagus, *i.e* , they have degenerated and the products of degeneration have been cast, in part, at any rate, into the blood stream Renovation of the median duct quickly ensues (fig. 117); embryonic cells growing inwards and downwards from the regenerating epithelium of the mouth and pharynx pass among the disintegrating cells, nourishing themselves perhaps, in part, at their expense.

The cells, however, do not grow back along the duct beyond its point of bifurcation; forsaking the old larval salivary duct here (the larval ducts at this point do not appear to be dead yet) they grow as a slender, hollow column up the back of the head and terminate in the neck. From the duct at a point about one-quarter its length from the mouth, the salivary gland of the imago develops in the second day of pupal life. I have not observed the process, but it seems unlikely that the gland should be formed in any other way than by a thickening of the duct.

Meanwhile, the remainder of the larval salivary glands disappear. In the larva shortly before pupation the greatly hypertrophied cells are to be observed undergoing obvious degeneration Numerous minute globules are to be seen oozing out from the gland cells (fig. 149) into the cavity of the gland, in the same manner as I have described above in the hepatic caeca. The cytoplasm is even more highly vacuolated than usual. But about six hours later (four-hour pupa) the cells have entered into a state of granular disintegration. Parts of the cells are in a condition of fine *débris;* other parts seem to have till now maintained their structure. The whole organ is very fragile, and I have observed a case in which the tracheae of the forewings, growing downwards from the main trunks, have torn off a portion of the disintegrating tissue and carried it along with them (fig. 88).

Lying within the disintegrating salivary glands are great numbers of leucocytes, actively engaged in clearing away the *débris* (fig. 88). Indeed, it is difficult to state how much of the disintegrated tissue is removed in this manner, and how much in the more direct way of solution in the blood stream.

Of the occurrence of phagocytosis of the gland cells, however, there can be no doubt whatever. Indeed, the salivary glands, in their degeneration, offer as clear an example of phagocytosis as it is possible to wish for. But their death, degeneration, and even partial disintegration previous to phagocytosis are equally clear.

The bifurcated portion of the salivary ducts disintegrates at about the same time. The leucocytes, having removed the *débris* from the glands, now move forwards and absorb the ducts also, and in the pupa six hours old no trace of the larval glands is any longer to be recognized.

The metamorphosis of the insect intestine has been the subject of a number of distinct investigations, to which I can refer but briefly here. Weismann, Kowalevsky, Lowne, and more recently Pérez (1910), have carefully examined the process in *Calliphora*, and it seems to differ but little from that of *Nasonia*, so far as essential characters are concerned.

Deegener has investigated the metamorphosis of the intestine in the Coleoptera *Hydrophilus* (1910), *Cybister* (1904), and in *Malacosoma* (1908); while Rengel has made observations on *Tenebrio molitor*, and several water-beetles.

The metamorphosis of the intestine of the silkworm has been investigated by Verson (1898, 1905); Poyarkoff (1910) examined that of a Chrysomelid beetle *Galeruca;* and Russ (1908) studied it in the Trichoptera.

The observations of these workers differ considerably, and while differences in the material dealt with may account in part for the discrepancies, misrepresentations must not be forgotten. Thus, while the formation of a replacing epithelium in the midgut, confined to the pupal period, and similar to that occurring in *Nasonia*, is fairly frequent, it appears to be absent in some forms. For example, Deegener could not observe it in *Malacosoma;* in the Trichoptera Russ failed to observe it, and regarded a constricted part of the imaginal midgut as functioning in its place. Verson was not able to see it in the silkworm; since its function is to absorb the products of degeneration of the larval midgut, its absence in the silkworm may be correlated with the voiding, as observed by Verson, of these degeneration products through the anus, shortly before pupation.

If the observations of Verson are correct, the process offers a curious type of inefficiency—the waste of certain useful storage materials—which does not occur in *Nasonia*. In

Cybister Deegener describes a second temporary epithelium, found late in larval life, and inserted between the old larval and temporary pupal epithelia. It should be noted that the temporary pupal epithelium is a very transient structure, and that its absence in some insects is only apparent.

In *Galeruca* Poyarkoff described a very interesting rejuvenation in the cells of the fore- and hindguts, similar to that occurring in the integument. In the silkworm, according to Verson, and also probably in the Coleoptera, there is a cell proliferation in the epithelium of the fore- and hindguts previous to each larval moult. This is evidently comparable with the proliferation of the fat cells of *Galeruca* as observed by Poyarkoff. Its significance will be explained in the second portion of this paper.

The *malpighian tubes* are of special interest. In *Nasonia*, and evidently in many other chalcid wasps, they are absent in the larva. In *Calliphora* Lowne believed them to undergo phagocytic destruction; but more recently Pérez has observed them to undergo during pupation a remarkable process of dedifferentiation, followed later by redifferentiation into imaginal organs. In *Galeruca*, however, there is a phagocytosis of old larval elements, accompanied by a development of embryonic cells to form the imaginal organs.

THE DUCTLESS GLANDS.

Under this heading three structures will be considered:—*(a)* The oenocytes; *(b)* a pair of lateral intestinal glands, occurring only in the larva, and which have not, I believe, hitherto been observed; and *(c)* a pair of dorsal abdominal glands, functional only in the adult insect, and also, so far as I am aware, hitherto unrecorded.

The Oenocytes.

The term oenocyte was first applied by Wielowiejsky in 1886 to certain very large cells scattered about among the cells of the fat-body of *Corethra*. Tichomiroff had already noticed then in 1882 in the silkworm; he observed their proximity to the tracheae and regarded them as of ectodermal origin. Wheeler in 1892 found them to delaminate from the ectoderm; Weissenberg in 1907, studying them in a chalcid wasp *Torymus*, came to a similar conclusion. Finally, Nelson (1915), examining them in the embryo of the honey bee, saw them invaginating in close relation with the stigmatic trunks from the lateral ectoderm. Berlese has described them in the hymenopteran *Tapinoma* as a pair of small masses of cells in the fifth to the eleventh segments.

Their segmental nature, together with their peculiar mode of development, strongly support the view of Lowne (1890) that they are homologous with the nephridia of annulata.

Their function is not definitely known, Berlese regarded them as excretory organs. Glaser, in 1912, extracted an oxidising enzyme from them. They appear to be scattered, as a rule, fairly uniformly amongst the cells of the fat-body, and this suggests that they are in some way related functionally to this structure. Perhaps their secretion contains some enzymes which drive the storage substances of the fat cells into solution, when the organism needs them.

Their behaviour during development seems to vary with different insects. In *Calliphora*, Lowne (1890) observed their histolysis during the early pupal period. Pérez (1910) observed their phagocytosis and described the oenocytes of the adult fly as arising from certain smaller imaginal oenocytes, present in the body cavity.

In *Galeruca*, Poyarkoff (1910) described certain larval oenocytes as undergoing phagocytic destruction at the end of larval life; others bud off numerous daughter cells, which become the oenocytes of the adult insect; the remaining portion of such a larval oenocyte becomes, after budding, the victim of the phagocytic activity of the fat cells and leucocytes.

In the ant *Formica rufa*, Pérez (1902) described a somewhat similar budding at the end of larval life. But in *Calliphora* this does not occur. In the honey bee, according to the observations of Nelson (1915), no cell division takes place in the oenocytes, once they have left the ectoderm from which they were formed. Similarly in the chalcid wasp *Torymus*, Weissenberg (1907) observed phagocytosis of the larval oenocytes at the end of larval life, while the cells of the adult wasp were produced from certain "imaginal oenocytes" lying within the body cavity.

When the mature larva of *Nasonia* is examined the oenocytes are seen as about eight to twelve large cells in each segment from the third to the twelfth, lying on either side of the intestine, and singly distributed, fairly evenly, through the fat-body. They are the oenocytes which have functioned during larval life, and are present already in the newly hatched larva. They are not unlike the cells of the fat-body in appearance at first, but as the latter accumulate storage products the resemblance soon disappears. Towards the end of the first instar the cells have grown a little; they are apparently spherical and measure 12μ to 13μ in diameter.

The cytoplasm is fairly clear, though with a very faint indication of granulation; the outermost regions are faintly vacuolated. The nucleus is large, measuring $5\frac{1}{2}\mu$ to 6μ in diameter; its chromatic contents are fairly evenly scattered and there is one large central karyosome.

During larval life the oenocytes grow considerably in size, having in the mature larva a diameter of about 45μ (sometimes as much as 55μ). The nucleus grows in proportion; its diameter is about 25μ. There is no evidence, therefore, of any marked difference in the nucleo-cytoplasmic ratio in the young and old larvae, so far, at any rate, as the actual volumes of the two materials are concerned. Whether there has been an increase in the quantity of chromatic material is more difficult to observe; there seems, however, to be no evidence that such has occurred; the great karyosome has disappeared and scattered its contents throughout the enlarged nuclear space; in its place, however, are to be seen one or a few prominent nucleoli often containing crystals; sometimes as many as twenty smaller ones are present instead. The cytoplasm is generally faintly granular, and usually heavily vacuolated in its outer regions (fig. 76). Generally the oenocytes are spherical, but often they become partly indented by other organs—tracheae or muscles—against which they have been pressed as they gradually grew in size.

In the late larva and in the earliest hours of the pupa these cells degenerate and finally disappear, and all stages of degeneration may be observed during this period. Often in the mature larva the oenocytes may show a division of the cytoplasm into an inner heavily granular and an outer less granular zone, which is to be looked upon, apparently, as the beginning of disorganization. But it is not till the time of pupation that actual disintegration occurs.

Usually the surrounding fat cells prevent the approach of leucocytes, and the oenocytes disintegrate spontaneously; large rents appear in the cytoplasm, and these develop into great holes; and at other times the whole cytoplasm degenerates into a fine powder, which is cast into the blood (figs. 176, 177).

But when the surrounding fat cells are not so densely packed as to prevent the leucocytes from taking part in the process, the latter appear (fig. 178), and, before chemical disintegration has had time to occur, they overwhelm the cells and, eating large pieces out of their substance, eventually devour them. So far as I could observe, the larval oenocytes do not persist beyond the early hours of the pupal stage.

Meanwhile, the oenocytes of the adult wasp have been developing. They are represented, in the defaecating larva, by small groups of closely packed, rather large cells (fig. 92); they still lie quite close to the integument, and though they occur elsewhere, are best seen at the posterior end of the larva. They do not occur in the head.

In the larva of the first instar they can be seen (fig. 175) as a small cluster of rounded cells, which have just grown down into the body cavity from the ectoderm of the integument. The cells measure about 10μ in diameter, the nuclei $5\frac{1}{2}\mu$. They have a large karyosome, but the chromatin is not markedly scattered through the nucleus.

During larval life they grow downwards and increase in size, attaining in the defaecating larva a diameter of 15μ, while the nuclear diameter has increased to 8μ; a small (plastin) nucleolus has begun to appear. The cytoplasm is homogeneous. I could not observe any increase in the *number* of the oenocytes, however.

But as the larval oenocytes gradually disappear these imaginal oenocytes replace them; they grow quickly in size, and leaving the sites of formation migrate, by amoeboid movement apparently, into the fat-body, among whose cells they scatter themselves. They do not grow as large as those of the larva (fig. 179), seldom exceeding 21μ in diameter, with a nucleus of 9μ. The latter may be granular and may show several small karyosomes. Occasionally in the four-day pupa they may actually contain a gigantic nucleolus, containing minute crystals; whether this is an indication of degeneration I cannot say.

It is important to note that the oenocytes are more prominent in the larva than in the adult insect. This agrees well with the view above expressed that their function is to break down the storage products of the fat cells, as the organism needs them, feeding being ever so much more active during larval life.

The Lateral Intestinal Glands.

On either side of the intestine, just below the paired hepatic caeca, are to be seen, in the mature larva, two organs, whose existence has not, so far as I am aware, hitherto been observed in insects. The organs are in the form each of a long chain of very large, elongated cells about 60μ in length, and presenting a weakly fibrous cytoplasm. Within this delicate cytoplasm is a great heavily granular mass, oval in shape, and about 55μ in length. It seems impossible that it should be anything but a greatly hypertrophied nucleus (fig. 169). A nucleolus may be present.

In the larva of the first instar this organ is indistinctly seen as a number of faintly fibrous cells just below the hepatic caeca; but as the larva grows they increase in size, and overlapping as they grow, eventually form an elongated, well-defined organ on either side of the intestine.

In the larva eight hours after defaecation a general disintegration of these cells begins. In places the cytoplasm and nucleus may degenerate into a fine powder and be cast into the blood. In other places the chromatin of the great nucleus clumps together in numerous small balls (fig. 170), and the cell cytoplasm, with these degenerate chromatic globules scattered through it, floats for a time in the semi-fluid contents of the abdomen, and finally, sometimes by the intervention of leucocytes, at other times by the chemical action of the blood, disintegrates. At other times the apparently normal cells may be observed, as late as twelve, or even sixteen hours after defaecation, to become the prey of the leucocytes; numbers of these have penetrated along a channel where the hepatic caeca have prevented the fat-body from encroaching too much upon the intestine, and here they fall upon the great hypertrophied cells, and a few hours later nothing but groups of leucocytes, and a little *débris*, remains to indicate the place where these gland cells have once been (fig. 147, l).

Just what these organs are I am unable to say. Their structure is similar to that usually seen in gland cells; the absence of any duct communicating in any way with the intestine or any other organ, indicates that they are structures analogous with the various internally secreting glands so well known in vertebrates.

The Dorsal Abdominal Glands.

These glands are to be observed in their mature condition only in the imago; it is not impossible that they have the same function here as the lateral intestinal glands have in the larva.

In the early larva they are to be observed as a single flat band of small closely packed cells, lying upon the mid-dorsal region of the intestine in the hinder part of the abdomen (fig. 173). They show a clear cytoplasm and are undoubtedly in an embryonic condition. But during larval life they grow considerably, and separating from one another form a pair of long chains on either side of the heart. One of these is shown in fig. 213. In the defaecating larva they are quite large, measuring 20μ in diameter. They are approximately spherical; their nucleus is branched, and their cytoplasm very vacuolated; during the remainder of larval life they grow a little in size, and are not unlike the degenerate fat cells of the late pupa in appearance (fig. 172). Nevertheless, they are in no way to be regarded as embryonic fat cells.

In the last day of larval life they proliferate, amitotically it seems, and in the larva sixteen hours after defaecation may extend over a considerable region of the dorsal part of the abdomen. Usually, however, they are confined to two chains, several cells in breadth, on either side of the heart.

In this condition the cells remain during the early pupal period. Gradually their cytoplasm becomes more homogeneous, and in the pupa shortly before emergence they may be observed as two irregular chains of unconnected groups of cells, running along the mid-dorsal portion of the abdomen. During pupal life the large cells as they occurred at the end of larval life seem to have undergone a process of incomplete fission, so that one now finds, not chains composed of individual cells, but chains of small *groups* of disc-shaped cells, arranged behind one another in little groups representing the cells from which they have been produced (fig. 171).

Within their clear, heavily eosinophilous cytoplasm lie numerous heavily chromatic granules which usually hide the nucleus. I have observed these glands in the free-living wasp, nine days old, and there can be no doubt that they persist throughout life.

It seems impossible to regard them as anything but internally secreting glands. Weismann observed certain large cells in close connection with the heart in Diptera, and spoke of them as the "cell chaplet." Lowne (1890) observed the same cells, and though he found them in the adult insect, he regarded them nevertheless as young fat cells. I do not know whether they are identical with the structures above referred to; these have, however, a remarkable resemblance in the immature state to fat cells. It is necessary also to point out that they do *not* constitute the pericardial septum, this structure being absent in the adult *Nasonia*

THE FAT-BODY.

It is to the great development of the fat-body, together with the disintegration of most of the larval structures, that the pupa of the insect owes its semi-fluid consistency, and the apparent lack of organization that a superficial examination first reveals.

In the newly hatched larva the fat-body is in the form of a number of large rounded cells, with very faintly granulated protoplasm and a large heavily granular nucleus, lying loose within the haemocoele. A single cell is usually large enough to occupy the greater part of the distance between the intestine and the body wall, but sometimes the cells lie "two deep." Great gaps separate adjacent cells, and through these the blood circulates. The fat-body is confined almost entirely to the thoracic and abdominal segments.

Shortly after the feeding has commenced, the cells of the fat-body begin to accumulate within the cytoplasm globules of fat (fig. 10), and at the end of the first larval instar a number of these, often quite large, are present, and the cell has increased considerably in size, measuring now about 25μ in diameter. In almost all the fat cells examined at this stage a great space was observed around the nucleus; this is probably an artefact.

During larval life a great growth takes place in the size of these cells, till at the end they may be as large as 92μ in diameter. This generally results in a partial crushing together of cells; but the increase in size of the haemocoele has been so great, that in places, even now, they lie loose within it (fig. 3). But after defaecation, when the space occupied by the intestine is so greatly diminished, the cells again separate from one another.

In the second larval instar the accumulation of a second type of reserve substance becomes manifest within the fat cells as a heavily staining, apparently structureless, mass around the nucleus. But a little later this mass breaks up into numerous minute granules, which move partly outwards, but are most concentrated in the more central part of the cell. Other granules are formed in the more peripheral regions, and these are much larger, often irregular in shape, being sometimes even angular, and stain heavily with haematoxylin. The fat cells have grown greatly in size, and accumulate mostly just below the cell membrane. All these storage substances, gathered up from the surrounding blood, lie suspended within the delicate, often exceedingly delicate, cytoplasmic meshwork of the fat cell.

In the larva some hours after defaecation has commenced, when the imaginal discs of the integument have begun to grow, at the same time considerably constricting the body volume, the pressure exerted upon the fat cells as they float loosely in the blood forces numbers of these cells into the cavities of the outgrowing appendages—wings, legs, antennae—while the cavity of the head, which in the feeding larva was not well provided with fat cells, now becomes crowded with these, as the contracting abdomen presses its contents forwards (*cf.* fig. 154).

As the abdomen contracts more and more during its transformation into the adult abdomen, the fat cells which remain within it become very tightly packed together, and it is only with the greatest difficulty that cell boundaries can be detected. There is no evidence, however, that any rupture of the cell walls ever takes place Between these fat cells lie the larval tracheoles, and the chemical disintegration rather than phagocytosis of these, in places which are usually quite inaccessible to the phagocytes, is readily understood.

The fat cells anterior to and above the brain are in the form of a single layer of cells, during pupal life they are often to be observed showing rhythmic movements, due, undoubtedly, to the contractions of the heart. The fat cells in the postero-ventral part of the head cavity are much more numerous; as in the thorax (alitrunk) they are loosely disposed and cell walls are always clearly visible.

From the late larva till the time of death of the insect the fat-body undergoes a gradual degeneration and absorption, and, although it is quite probable that the fat-body stores up reserve products as the imago feeds, yet at no time is there to be observed in *Nasonia* a formation of new fat cells; the same individual fat cells which have persisted in the senescent imago occurred already in the first larval instar. It is this gradual degeneration that I shall here describe.

In the larva at about the time of defaecation many of the larger grains of storage material within the fat-body begin to develop very minute crystals within them, and sometimes quite large numbers of these may be present, all within a single grain (fig. 92). In the small, more centrally situated, and eosinophilous grains these crystals are not to be seen, but frequently contain small chromatic granules, probably the pseudonuclei of Berlese. But these crystals do not, as a rule, persist long within the grain; already in larvae several hours after defaecation they are no longer to be seen. Even the chromatic granulations of the small grains seem to disappear in the early pupa. Sometimes, however, crystals are visible as late as several hours after pupation.

The nuclei of the fat cells assume curious appearances towards the end of larval life. The heavily granulated structure and general compactness of the nucleus is lost, and it may become finely granular and slightly branched, while at other times it elongates greatly and stretches as a great dumb-bell-shaped band almost from one side to the other of the fat cell (fig. 92). At no time have I observed nuclear division.

However complex may be the changes going on within these cells as they gradually liberate their storage substances and then die, the processes which are to be observed microscopically are easily described. The fat globules and storage grains begin to decrease in number, at first slowly, then rapidly. In the head of the three-day pupa the fat cells have greatly diminished in size, they still contain a few grains and fat globules (fig. 96), but while in the adult larval fat cells these reserve products give the cells their characteristic appearance, the cytoplasm merely acting as a supporting tissue for them, in the late pupal period these conditions are reversed. The faintly granular cytoplasm now predominates, and only scattered grains and fat globules remain. The fat cells, however, now no longer resemble those of the first instar before the reserve materials accumulated. They float as irregular shapeless masses within the cavity of the head, and although a few survive the pupal period, most have degenerated before then; their reserve substances have all passed back into the blood from which they originally came, and the brain and the great eyes have doubtless grown at their expense.

These degenerate shapeless cells are finally, in the four-day pupa, removed by the leucocytes (fig. 97); not before this time, however, does any phagocytosis occur.

In the thoracic region the fat-body undergoes similar degeneration, and though a few fat cells in the ventral portion of the thorax persist, even throughout imaginal life, yet the greater number disappear entirely during the fourth day of pupal life; at the expense of their reserve substances the great wing-moving musculatures have developed.

In the newly formed pupa the thoracic region contains numerous fat cells (fig. 154), but as the longitudinal muscles grow they begin to push these aside. Those cells which have been so unfortunate as to become entangled amongst the growing muscles become stretched into elongated masses, very well seen in the thirty-six hour pupa; the others retain their usual shape. But the result is always the same; the cells gradually give up their reserve products (fig. 98), and like the fat cells of the head, remain as irregular hulks, whether compact or branched, activ greatly elongated and compressed between the thoracic muscles. Here in the fourth-day pupa they are fallen upon by the leucocytes and soon are no longer seen.

Similar degeneration may be observed in those fat cells which were forced into the cavities of the appendages.

In the abdomen the degeneration during pupal life is much less complete; indeed, although occasional leucocytes may be observed lying amongst the cells of the fat-body as late as the fourth-day pupa, yet these seem to have no effect upon the fat cells. The latter remain practically at a constant size; the fat globules which they contain may diminish in number, but do not disappear. The grains, however, disappear to a large degree; the large grains are far less numerous, and the smaller eosinophilous grains are almost totally absent.

Even after emerging from the pupa, the degeneration of abdominal fat cells continues, and it is undoubtedly at the expense of the fat-body that the ovaries of the female grow so greatly. Even after nine days, however, cells of the fat-body are still present in the abdomen, though considerably less numerous. I have not observed their disappearance, but it is unlikely to be different from what occurs in other places during pupal life. Indeed, as far as the fat-body is concerned, it is clear that the retrogressive development does not cease at the time of emergence. It continues apparently right throughout pupal and imaginal life.

At times I have observed the large granular degeneration masses cast out by the larval integumental cells, lying embedded within individual fat cells (fig. 91, x); it seems, then, that the fat cells, in spite of their inert appearance, must possess a certain capacity for phagocytosis.

The behaviour of the fat-body does not appear to be identical in all insects. Berlese (1901) observed multiplication of the cells of the fat-body in the silkworm, as well as in certain *Coleoptera*. Poyarkoff (1910) observed it in *Galeruca*. In *Calliphora*, on the other hand, it does not appear to occur.

Poyarkoff (1910) has described phagocytic activity of the fat cells of *Galeruca;* but it does not seem to have been observed elsewhere. On the other hand, he observed also a phagocytosis of individual cells of the fat-body, which Pérez observed also in the ants (1902), and in *Calliphora* (1910). Kowalevsky (1885), on the other hand, described phagocytic histolysis of the fat-body in *Musca vomitaria*. In living material he observed the leucocytes crawling over the fat cells, penetrating into their interior, and eventually destroying the whole cell. It may be [illegible] his takes place under the influence of the egg albume [illegible] sum [illegible] ich Kowalevsky placed the tissues; but no further evi [illegible] as accumulated to show that the phagocytosis occurs normally on an extensive scale, except certain observations by Lowne (1890). This investigator described the leucocytes as entering certain fat cells, and then, having proliferated rapidly around the nucleus, as migrating outwards; the peripheral ones are much smaller than the more central ones, which are frequently multinucleate. The leucocytes then leave the fat cell, which has lost, in the meantime, its cell membrane, and enter the blood stream. He even considers the view that the leucocytes have been formed within the nucleus of the fat cell. Pérez could not confirm the observations of Lowne and of Kowalevsky, and both Weismann and Ganin, working with similar material, observed that the fat-body disappeared only very slowly, and that many of the fat cells persisted even in the imago

In *Nasonia* there is a total absence of phagocytic destruction of the food-laden fat cells.

Several investigators have described a development in *Calliphora* of new fat cells for the imago. Weismann (1864) was the first to notice it; Berlese (1899 1901) examined the process more closely, and concluded that the imaginal fat cells were developed by the differentiation of the "spheres of granules." This conclusion is the more remarkable when it is remembered that these bodies were regarded by Berlese not as gorged leucocytes, but as disintegration products of larval cells. Henneguy (1904) adopted this view, but regarded the "spheres of granules" as leucocytic in nature.

According to Supino (1900), on the other hand, the fat cells arise from certain mesenchyme cells, and Pérez (1910), in support of this view, figures a number of embryonic imaginal fat cells.

The observation that a new development of fat cells, whatever the nature of the process, does occur, seems to be well established. In *Nasonia*, however, I could observe no indication whatever that this took place. It is perhaps useful to point out that the cells of the dorsal abdominal glands above described show a remarkable resemblance to young fat cells, but never develop into these.

The Function of the Fat-body.

Although the fat-body is a highly characteristic tissue and occupies so large a portion of the insect, yet its function has been rarely investigated, and is but little understood. It is beyond the scope of this paper to examine this question except in so far as it has a bearing on metamorphosis.

It seems probable that the fat-body of *Nasonia* exhibits a limited phagocytic activity; Poyarkoff has seen it in *Galeruca*, and in *Nasonia* it appears also to be present.

Berlese regarded the fat cells as intimately concerned with nutrition; food passed through the walls of the intestine, and was absorbed in an apparently solid state into the fat cells. Migrating inwards it came into the neighbourhood of the nucleus. Then it migrated outwards again, and was peptonised during its progress within the cell. The food was seen in the form of the large and small grains which are so prominent within the fat cells; the pseudonuclei, Berlese regarded, without any evidence whatever, as the enzyme, which brought about this hydrolysis.

In 1889 P. Marchal observed that treatment of the fat cells with acids would cause the appearance of uric acid crystals within them, and he regarded the fat-body as an excretory organ.

In 1908 K. Samson observed that in the moth *Heterogenea* the fat cells stored up vast quantities of urates during metamorphosis. The fact seems, then, to be fairly well established that the fat-body is in some way concerned with excretion; but whether it is a depositing place for urates, found elsewhere in the body, or whether the urates within it are the result of its own deaminising activity, these observations do not allow one to decide.

In *Nasonia* crystals are present during late larval life, and a considerable portion of the pupal period, and they disappear as the urate crystals begin to accumulate within the intestine. Similar crystals are often seen in the nucleoli of degenerating larval cells, and it is possible that their presence within the fat cells is only secondary, their seat of origin being within the active tissue cells. In the larva of *Nasonia*, as already pointed out, excretory organs are absent, and unless nitrogen is liberated as ammonia, no removal of excretory products takes place.

Recently (1920) Pérez has shown that during metamorphosis there is no evacuation of urates by the malpighian tubes until towards the end of pupal life. Then there is a sudden accumulation of urates within the intestine (just as occurs in *Nasonia*), and this coincides with a disappearance of the pseudonuclei from the fat-body. He regards the fat-body, therefore, as an "accumulating kidney."

These various investigations seem to show that the fat-body may remove urates from the blood during the metamorphosis, and should be especially useful in such an insect as *Nasonia*, where the removal of nitrogen during larval life does not seem to occur.

The fat-body has besides another great function—that of storing reserve materials. These are mainly in the form of fat globules and of the numerous grains which are so characteristic of the tissue. The latter are usually regarded, though without any direct chemical evidence, as protein in nature.

It is this capacity of storing food materials that is so important in insect metabolism, and it is largely this that has enabled the insect metamorphosis to be evolved.

THE GONADS.

The Male Organs.

The testes are present in the earliest larva as a pair of large pyriform structures, situated on either side of the rectum. The narrow end of each is attached by a thin stalk, which is hollow, to the ventral part of the ninth abdominal segment, and the whole organ lies vertically to the longitudinal axis of the larva (fig 185).

The testis is covered by a membrane consisting of rather flattened cells—the "serosa," or reflected abdominal "peritoneum." Lying within the sac so formed is a great mass of very closely packed spermatogonia, somewhat rounded cells, measuring about 6μ in diameter. Each contains a large clear nucleus, the chromatin of which is concentrated into a small heavily staining karyosome ("vesicular" type of nucleus) (fig. 186). Cell division does not appear to be going on at this time.

Supporting these spermatogonia is a fine connective network, very difficult to detect, it consists essentially of a number of branching cells, not unlike vertebrate nerve cells in appearance (fig. 186), and somewhat smaller than the spermatogonia, the network being formed by the junction of adjacent cell processes.

During larval life the spermatogonia increase in number, the testes in the defaecating larva being in the form of two rounded organs, much longer than the testis of the first larval instar. The spermatogonia have not increased in size, indeed, they are somewhat smaller than those occurring in the first instar, being now about 4½μ in diameter. The connective tissue network has become more prominent.

The "stalk" of the organ, which is now definitely recognizable as a vas deferens, has increased considerably in length; its wall consists of a single layer of cubical cells, covering which, of course, is the serosa. The lowest portion of the vas deferens now begins to dilate. The cells lengthen greatly, and change from cubical into elongated columnar cells. It is the rudiment of the vesicula seminalis, and is already well developed in the larva twelve hours after defaecation. It lies in close contact with the proliferating cells of the invaginated ventral part of the ninth abdominal segment, from which, as above described, the penis is beginning to develop. But its cavity does not yet possess any communication with the exterior.

At this stage also (twelve hours after defaecation) the action of the connective tissue in the testis is clearly visible, resulting in the binding together of the spermatogonia in little groups of twenty to thirty, all clustered tightly together. By the time the larva pupates, these clusters of spermotogonia have loosened considerably; the connective tissue cells and network are clearly visible. Sometimes the connective tissue undergoes considerable hypertrophy at this time, but this is probably to be looked upon as an abnormality.

The vesiculae seminales have meanwhile been enlarging, and now project forwards as a pair of great thick-walled outgrowths from the lower portions of the two vasa deferentia. The wasp is, then, provided with three vesiculae seminales, two-paired, and mesodermal in origin, formed as dilatations from the lower portion of the two vasa deferentia, the other a single forward dilatation of the cavity of the penis, as described more fully above (fig. 27). The cavity of the penis is developed about this time, and, shortly after, the lower parts of the vasa deferentia open into it.

At this time, too, the testes are beginning to elongate and extend forwards. The spermotogonia still measure 5μ to 6μ in diameter.

During the next twenty-four hours the male organs grow rapidly. The vesiculae seminales elongate somewhat and become "sausage-shaped." That portion of the vas deferens which has opened into the penis now increases in length and pushes the paired vesiculae upwards, so that they now come to lie more towards the middle of the abdomen. The testes, themselves, meanwhile have elongated still further, and are now situated dorsal to the intestine, just below the body wall. Their own growth, and the elongation of the vasa deferentia, result in their now occupying the upper regions of the fifth and sixth abdominal segments, having migrated through the seventh and eighth segments during larval and early pupal life.

In the two-day pupa the openings of the vasa deferentia into the penis have become very wide; except for this change no marked alterations are visible in the male organs. The spermatogonia are still 5μ to 6μ in diameter.

In the three-day pupa the testes fuse anteriorly above the intestine, and with this change, attain their mature proportions.

Throughout the whole of larval, and the greater part of pupal life, the spermatogonia remain at a fairly constant size, *viz.*, 5μ to 6μ. Sperm formation begins in the three-day pupa; I have, however, seen cases where precocious sperm formation took place in the pupa of thirty-six hours. The sperm has a rounded head about 2μ in diameter; the mid-piece is generally quite distinct and the tail very long (about 28μ).

The frequent precocious development of the spermatozoa is especially curious; thus, while pupae three days old may be quite devoid of tailed spermatozoa, the pupa of fifty-six, and even thirty-six hours, may have testes which are absolutely crowded with sperms.

It is beyond the scope of the present paper to enter into any detailed account of the cytology of spermatogenesis in *Nasonia*.

The Female Organs.

The ovaries, like the testes, are present in the earliest larvae, and are not to be distinguished from these in any way. There is, therefore, no need to describe them here. Even in the larva at the time of defaecation it would be difficult to determine the sex of the larva, were it not for the presence of the rudiments of the ovipositor, and the absence of vesiculae seminales. The size of testis and ovary is fairly identical; the oogonia measure 5½μ to 6½μ in diameter, and, in places, are arranged in little clusters of four cells surrounded by a few coarse, unbranched cells, homologous, perhaps, with the connective tissue network of the testis. The greater number of oogonia, however, do not accumulate in such masses, and the clusters are to be regarded as recently divided cells, which, on account of the rapid cell division, have not had time to separate. The oviduct is also a tube considerably wider than the vas deferens; proximally it is composed of flattened, slightly branched, cells; distally of cubical cells.

In the larva at about the time of defaecation a slight ingrowth of cells takes place between the first and second pair of ovipositor appendages. In the larva, some sixteen hours later, this ingrowth has become more prominent and is beginning to undergo a certain amount of folding. It is the rudiment of the vagina. When first formed in the defaecating larva, it consists of loosely arranged epithelial cells, which, however, soon merge closely together. The oviducts do not at this stage open into the vagina, although they terminate close to, and already fit tightly against the ingrowing vaginal invagination. The ovaries have now grown into a pair of long spindle-shaped organs, running vertically and lying close beside the metamorphosing intestine; they reach nearly to the dorsal body wall and approach each other closely here, but do not, as yet, show any sign of growing forwards (fig. 154).

The ovary itself consists of a great mass of oogonia, rounded or hexagonal in shape, and closely packed together. The whole mass is covered with a thin layer of minute cubical cells, continuous with the cells forming the oviduct; while covering the whole ovary is a thin serosa (fig. 187).

A few hours after the larva has pupated the vaginal invagination grows backwards and begins to extend considerably in size, and the two oviducts, which for several hours have been tightly pressed against it, now eventually communicate with its cavity. At this time, also, two outgrowths are formed from the posterior portion of the vagina, one grows very rapidly and extends backwards within a few hours to a length of about one-third that of the abdomen Already at this stage it has an extremely narrow lumen, and consists entirely of embryonic cells, similar to those of the vagina. The other outgrowth is considerably shorter, never exceeding half the length of its fellow. Structurally the two are the same at this stage; I shall speak of them here as the "accessory glands"

At this time, also, a pair of distinct thickenings are seen, one on either side of the antero-dorsal part of the vagina. They will develop into the "lubricating glands" of the adult (fig. 184). They are composed of very elongated cells, arranged irregularly in two ill-defined lines

Meanwhile the ovary has commenced to grow forwards, but this forward growth is accompanied by a curious partitioning of the whole ovary The layer of small cubical cells covering it, and the overlying serosa begin to grow inwards at the tip of the ovary, in such a way as to divide the whole organ into four distinct compartments (fig 192).

As the ovaries continue to extend forwards the newly formed portion must likewise possess this four-chambered appearance. On the other hand, an extensive back-growth of these partitions eventually divides the whole ovary and even a considerable portion of the oviduct, into these four characteristic chambers; indeed, only the terminal portion of the oviduct, adjacent to the vagina, remains devoid of partitions. During the next two days the ovary grows forwards on either side of, and above, the intestine, and, in the advanced pupa eventually terminates slightly behind the anterior wall of the abdomen.

In the twenty-four hour pupa, meanwhile, a new process of partitioning of the ovary has commenced. Ingrowths of the protecting membranes of the ovary divide the anterior tip of each of the four chambers into three secondary parts. The partitions do not extend deeply, but each ovary as it grows forwards now breaks up, as a result, into twelve papillae; these elongate rapidly and form twelve ovarian tubules, which comprise the anterior end of each ovary (see fig. 180).

The ingrowth of the external parts of the ovary becomes very pronounced in the oviduct of the pupa of about two days, being now in the form of a great connective tissue stroma, with four channels, each lined by a layer of flat cells, running along it.

The ovaries, then, so far as external appearances are concerned, reach their adult condition in the pupa of about two and a half days. Terminally each consists of twelve ovarian tubules, containing sexual cells, and protected by a thin "capsule." These tubules now open into a great oviduct divided by a connective tissue stroma into four channels for the greater part of its length; but devoid of such partitions distally, near its opening into the vagina. The structure of the mature female is shown in fig. 180.

The further development of the contents of these tubules, the oogonia, will be described below.

It is necessary to examine now the changes undergone by the vagina and its accessory glands.

In the four-hour pupa the vagina is a small sac-like invagination of the ventral body wall between the first and second ovipositor appendages; its walls consist of long columnar undifferentiated cells. During the next twenty-four hours it grows back rapidly, and extends considerably also in height, forming in the thirty-six hour pupa quite a spacious chamber on the ventral body wall, close behind the beginning of the ovipositor; the vagina is connected now by a distinct "neck" with the exterior. Its walls are composed of cubical cells; those on the upper side of the vagina, and those on the anterior part of the ventral surface, develop each a sharp forwardly pointing "tooth," the inner surface of the vagina presenting therefore a distinctly rasp-like appearance. As development proceeds the cells on the upper walls elongate greatly, and adopt a columnar shape. A very delicate chitin layer is formed within the vagina, and this layer presents, of course, the same rasp-like appearance that occurred merely as a protoplasmic mould a day earlier. The function of this curious roughened surface is obviously to help in the laying of eggs. The cells themselves frequently present a clear, somewhat vacuolated protoplasm, such as is usually seen in mucin-secreting gland cells.

On the antero-dorsal sides of the vagina a curious development of the epithelium has been going on, which results eventually in the formation of the lubricating glands. The epithelium, as already stated, consists, roughly, of two layers of very elongated cells; of these cells the outer form each a gland cell; the inner, the duct of the gland cell. The outer cells increase considerably in size, and breaking loose from the epithelium grow inwards a very short distance. They are already clearly visible in the pupa of fifty-six hours, as large cells with granular cytoplasm. They increase in size during the pupal period, and are seen in the adult insect as a pair of small groups of about thirty large cells on either side of the anterior part of the "neck" of the vagina (figs. 180, 184). Meanwhile the cells of the lower layer have been differentiating. They elongate considerably, and develop, after about two days, a very long narrow lumen, one end of which becomes applied by a funnel-shaped process to a gland cell, while the other opens into the upper part of the ovipositor. Practically the whole of the cell cytoplasm becomes converted into this duct, the nucleus itself remaining as a small heavily staining swelling upon it.

The function of these glands is apparently to secrete a lubricating liquid into the chitinous ovipositor, and aid in the passage of eggs down this structure, while assisting it, at the same time, to bore through the hard shell of the fly pupa during oviposition. This liquid is clearly seen during the act of laying as minute oily globules which ooze through the sheaths of the ovipositor.

On the upper surface of the vagina two small rounded vesicles are seen (figs 180, vsc.), whose walls are composed of long columnar cells. They appear to correspond to structures which in the honey bee are described as aiding in copulation, a kind of bursa copulatrix; what their actual function in *Nasonia* is, I am unable to say; that they have nothing to do with copulation seems fairly certain, since this takes place by the application of the penis of the male to the termination of the ovipositor of the female.

The first stages in the development of the great accessory glands from the posterior part of the vagina have already been described. Two curious changes now take place in connection with the openings of these glands, which tend to confuse their true origin: firstly, the vagina grows backwards over the openings of the glands, so that they now arise not posteriorly from the vagina, but from its antero-ventral region; secondly, shortly after the glands grow out from the vagina they draw a portion of the cavity of this structure after them, so that they open in the twenty-four hour pupa, not directly into the vagina, but into a separate chamber, lying beneath it, and opening into the "neck" of the vagina, shortly before its opening into the ovipositor.

The cells on the upper part of this sac elongate considerably to form a columnar epithelium; in the late stages of pupal life (four and a half-day pupa) their very powerful staining capacity shows that they have now developed into gland cells.

The two posterior accessory glands increase in length, and in the pupa one day old have approximately attained to their adult dimensions. The glands are not symmetrically placed; that on the right side is much the longer of the two (fig. 180), and extends backwards to a point one-quarter the length of the abdomen from the posterior extermity of the insect. Its cells are large, and continue to develop a lumen, which runs right down the gland, but increases slightly in diameter. The cells soon lose their embryonic appearance; in the pupa at the end of its first day they are already wedge-shaped; they have a large nucleus but present a fairly clear cytoplasm. In the thirty-six hour pupa, however, some of them show a distinct indication of developing granular cytoplasm. The granulations increase in number, so that in the mature pupa the whole cells become packed with granules; the glandular nature of the organ is no longer to be questioned (figs. 182, 183).

The gland on the left side develops into a structure only two-thirds the length of its fellow. Distally its lumen is distended into a round vesicle, and this becomes connected on its anterior side with a round, solid ball of cells, the spaces between which appear to open into the vesicle (figs. 180, 181).

The function of these glands is doubtful. That they are not "colleterial glands" (glue-secreting glands) seems certain, for the wasp has no need to fasten her egg to an exposed surface. It is much more probable that they are lubricating glands, whose secretion aids that of the true lubricating glands in facilitating the passage of eggs down the ovipositor, and the entrance of the ovipositor through the hard shell of the fly pupa during oviposition.

To somewhat similar glands in *Calliphora*, Lowne has applied the term "Parovaria." As late as 1895 he maintained, in his well-known monograph on that insect, that the germinal material of the egg was developed in the parovaria, while the yolk was produced in a pair of great "yolk glands" (really the ovaries), and that the large oval masses of yolk, as they pasesd down the uterus, first applied their microphyles to the opening of one of the parovaria, and received their germinal vesicle; then applied their micropyles to the openings of the spermathecae, and were fertilised. Lowne then drew the unfortunate comparison of the "insect vitellogen" with that of the flat worms.

It is necessary to consider now the history of the oogonia, in their process of development into ova.

Throughout larval, and the greater part of pupal life, the oogonia remain as small cells closely packed together, measuring from $5\frac{3}{4}\mu$ to $6\frac{1}{2}\mu$ in diameter; each contains a large nucleus of the "vesicular" type, *i.e.*, the chromatic material is contained in a minute granule, lying within a colourless nuclear "sap." But towards the end of pupal life these cells which lie in the twelve pairs of ovarian tubules begin to undergo a series of changes, which transform them into mature ova. A consideration of the nuclear changes is beyond the scope of this paper; I shall confine my description to the more obvious changes in the cells.

The oogonia in the distal part of the tubules divide actively (without any centrosome, so far as I could observe); those in the proximal part of the tubes cease to divide and arrange themselves in little balls, which pass down the tubes (fig. 189) and eventually enter the four channelled oviducts. The grouping up of the cells into these little balls can be clearly observed at the point between the region of irregularly arranged cells and that at which the last ball has been formed. No difference is at this stage visible in any of the cells of any of these little masses (fig. 189). Very soon, however, changes begin. The central cell of every alternate group begins to grow; it is the future ovum, and the surrounding cells form the follicle; the balls of cells on either side of these developing ova are the groups of nutritive cells.

The follicle cells at first do not undergo any appreciable changes. The ovum, however, is soon characterized by a quickly growing nucleus. The nutritive cells soon increase in size; indeed, by the time the fourth group of cells is forming, the nutritive cells of the first have already grown to 11μ in diameter. The egg meanwhile grows rapidly, but though it probably develops at the expense of the follicle and nutritive cells, these do not appear to suffer greatly; the follicle cells maintain a remarkable constancy in size. When the egg has reached a diameter (it is now slightly oval) of 12μ, the follicle cells are still 5μ to 6μ in diameter; they have, however, become somewhat cubical instead of rounded in shape, so as to form a more complete covering for the ovum.

When the egg reaches a length of 52μ, the first polar body is formed; it is very large, measuring some 10·3μ in diameter, and is clearly seen lying beneath the follicle cells (fig. 190). Even now, however, the follicle cells have not diminished appreciably in size; indeed, although the ovum is probably living partly at their expense, they may actually show an increase in size, reaching at times a thickness of 7μ.

The behaviour of the nuclei of the nutritive cells, however, is quite different. The nucleus grows greatly in size and may reach a diameter of 5μ; the chromatin is scattered regularly throughout it, and is no longer contained in a karyosome.

Eventually, however, the follicle cells also begin to grow, but the growth of the nuclei never ceases. When the ovum measures 150μ in length the nuclei of the surrounding follicle cells measure 17μ in diameter. Although the egg is living at the expense of the nutritive cells, these also grow greatly in size; it is difficult to detect their cell boundaries, but they show the same disproportionate growth between nucleus and cytoplasm, *e.g.*, when the egg measures 18μ in length, the nutritive cells measure about 11μ in diameter; their nuclei 5·5μ.

We see, then, that the follicle cells and nutritive cells undergo certain characteristic changes as the ovum develops, they remain of a fixed size for a time, or increase in size more or less rapidly, but their growth is not proportionate to that of the ovum. Their nuclei, on the other hand, grow rapidly in size, and the rate of increase of these is much greater than that of the cells containing them.

Now it has been clearly shown by Morgulis (1911) that the body cells of salamanders undergo during starvation a rapid diminution in size; also that the nuclei themselves become smaller, but that the rate of diminution in these soon becomes less than that of the cytoplasm. As a result the ratio of nucleus to cytoplasm is much greater than in normal cells. Exactly how this is to be interpreted is difficult to say. It may be that the nucleus has greater powers of resistance to starvation than has the cytoplasm; on the other hand, it seems much more correct to assume that there is an intimate relation between the cytoplasm and nucleus, and that the condition which we find in a starved salamander cell is such as will enable it to exist the better under these changed conditions. And although this phenomenon is by no means universal among starving cells, still it seems to suggest that a great increase in the nucleo-cytoplasmic ratio is a sign that the cell is living under certain adverse conditions.

It is in this way, possibly, that the remarkable changes in the nucleo-cytoplasmic ratio, undergone by the nutritive and follicle cells, is to be interpreted. That the nutritive cells nourish the ovum is universally recognized; that the follicle cells nourish the ovum is more difficult to prove. However, the fact that the latter cells undergo this same nuclear change is a curious piece of evidence in favour of this view.

Considered in this light, the nutritive and follicle cells exhibit the interesting combined effects of nourishment and starvation. Their growth in size is due to their receiving a large supply of nourishment; the preponderance in the size of the nucleus is the result of the parasitic habit of the ovum.

The ova continue to grow rapidly, reaching at the end of pupal life their mature length of about 300μ. They are ready for fertilization immediately the wasp emerges.

The nutritive cells, on the other hand, gradually diminish in size, and are left as a little clump of disappearing cells in close contact with the ovum.

In the female, but not in the male, is a pair of glands (fig. 188) lying in close contact with the anterior extremity of the ovarian tubules They consist of large cells with granular cytoplasm, and open on to the abdomen on either side just behind the petiole. The glands themselves contain a distinct cavity. I have not observed their mode of development, but they seem to be formed simply as a depression in the ectoderm early in pupal life.

What the function of the glands is, is difficult to determine. Their occurrence in the female alone indicates that they are sexual excitants of some kind.

THE NERVOUS SYSTEM.

As early as 1832 Newport, comparing the simple type of nervous system of the larva of *Sphinx ligustri* with the more specialized condition, with its concentration of ganglia, that he observed in the adult moth, showed that during metamorphosis a "migration" of ganglia must occur · and examining the pupa at various stages of development, he was able to observe various intermediate conditions between the larval and imaginal structures.

But the first histological observations were made by Weismann in 1864. He showed in the muscids that a process of histolysis was going on within the ventral nerve cord; the nerve cells become dark and granular, while the whole nerve cord changes into a structure of very fragile consistency The peripheral nerves become very pale, and losing their fibrillated appearance, develop fine refractile globules in their interior

In *Corethra*, on the other hand, a much simpler process occurs; the central nervous system undergoes no fundamental changes, and only where new organs develop are new peripheral nerves formed.

In 1889 Van Rees investigated the nervous system in *Calliphora*, but could not confirm Weismann's observation on the fatty degeneration of the peripheral nerves. So far as I am aware, however, the cellular changes in the nerve cord and peripheral nerves have never been investigated, and even the work of Weismann does not contain any direct observations on the fundamental cell changes going on here during metamorphosis.

·The metamorphosis of the brain has received considerable attention from Viallanes (1882, 1884, 1885), and much more recently from Bauer (1904). I shall refer to the work of these observers below.

The Ventral Nerve Cord and Peripheral Nerves of the NASONIA *Larva.*

In the newly hatched larva the ventral nerve cord is visible through the transparent cuticle as a thick column, not very distinctly marked off into ganglia, and passing from the third segment backwards along the mid-ventral line to the eleventh (fig 1). In front, the nerve cord communicates by a pair of circum-oesophageal connectives with the brain, which occupies a large part of the second segment. From the brain a pair of minute nerves is given off to the small rudimentary sense papillae (antennae) on the first segment. Other nerves doubtless leave the brain, and supply various parts of the head, but I have not been able to observe them definitely.

It is only with the greatest difficulty that ganglia can be observed in the ventral nerve cord at this period, and the presence of lateral nerves is the best indication of their position. These nerves are quite prominent and are even clearly visible through the transparent cuticle (fig. 1) The posterior ones are the largest and supply the greater part of the hinder region of the larva. Lying in front of the brain, just dorsal to the oesophagus, is a minute rounded stomotogastric ganglion (fig. 117), connected by a pair of nerves that surround the narrow oesophagus with the circumoesophageal connectives near the junction of these with the first ventral ganglion.

During the growth of the larva there is a corresponding increase in the size of the nervous elements, and it is not till a considerable time after hatching that the various ganglia can be clearly observed. Of these, twelve, not including the brain, are present (fig. 225, a). The last one can be seen in longitudinal sections to be composed, apparently, of three very closely fused ganglia, so that the larva possesses at least fifteen of these. No account is taken here of the possible multiganglionic nature of the brain.

Covering the central nervous system and the peripheral nerves of the newly hatched larva is a very delicate membrane, composed of two kinds of cells: the purely larval cells, and the embryonic imaginal cells which will replace them during the metamorphosis. Both these kinds of cells are very flattened and embrace the masses of new cells closely; they constitute a part of the splanchnopleural portion of the "peritoneum."

The nerve cells are of two kinds. Lying usually on the outside, but sometimes also scattered partly within the nerve cord, are large cells, devoid of a fibre, with big nuclei, containing a large karyosome and several scattered chromatin granules (fig. 10). They are *neuroblasts* from which the adult nervous system will later develop. Lying more internally are the functional larval nerve cells, considerably smaller than the neuroblasts, and measuring about 4μ in diameter. Each has a large nucleus, surrounded by a very minute quantity of cytoplasmic material, all the rest of the cytoplasm being found in the long nerve fibres. The nerve cells are themselves held together by a network of neuroglia cells, usually difficult to distinguish from the ordinary nerve cells, but clearly visible in the region between adjacent ganglia.

The nerve fibres are collected in two cylindrical nerve strands running along the length of the nerve cord and giving off branches to form the peripheral nerves in the various ganglia. The double nature of the nerve cord is thus clearly recognizable. It is usually only with the greatest difficulty that the individual nerve fibres can be seen, so minute and compressed together are they.

The cells of the stomatogastric ganglion are similar to those of the ventral nerve cord.

The Post-embryonic Development and Metamorphosis of the Ventral Nerve Cord.

The cells of the nerve cord, like those of all the other specialized larval organs, do not proliferate, but merely grow in size.

The splanchnopleural covering of the nerves and nerve cord may first be considered. While the embryonic imaginal cells do not undergo any visible changes during the larval period the larval cells grow greatly in size, and at the end of the feeding period show the usual signs of degeneration (figs. 221, 222), *i.e.*, their cytoplasm becomes granulated; the nuclei are long and oval, and greatly hypertrophied, measuring 17μ in length, and contain a few scattered granules. The usual prominent nucleolus, so characteristic of the senescent cells of *Nasonia*, is present.

But shortly before defaecation, the embryonic cells spring into activity, and dividing mitotically (fig. 222) rapidly absorb and replace the dying larval cells, so that several hours later the whole of the mesodermal covering of the nerve cord has been regenerated. Towards the end of pupal life some of the cells of this splanchnopleure develop great nucleoli, but beyond this no visible changes are to be detected during the pupal period. There is, therefore, no discontinuity in the splanchopleure during its metamorphosis. Moreover, as it acts as a sac to enclose the nerve cells, there can be no discontinuity of the nervous system as a whole during its metamorphosis, whatever the changes that may be going on within it. These changes are very profound, and the nervous system undergoes as marked a metamorphosis as does any other system of larval structures.

The increase in size of the larval nerve cells is difficult to estimate since most of their cytoplasm is contained in the long nerve fibres In the defaecating larva, however, the part containing the nucleus has usually grown from a structure which in the first instar measured about 4μ in diameter to one with a diameter of $4\frac{1}{2}\mu$ to 5μ, and sometimes slightly larger. The real increase in the size of the cells may be judged when the growth of the great nerve strands is taken into account. In young larvae these measure usually some $6\text{-}10\mu$ in thickness, while in the defaecating larva they have grown to a thickness sometimes as much as 30μ.

Towards the end of larval life these larval cells begin to develop large nucleoli and show the typical signs of degeneration.

In the nerve cord at about the time of defaecation the large neuroblasts—purely imaginal structures corresponding in every way with the other embryonic cells which lie dormant during larval life—begin to divide by mitosis, and a considerable increase in the number of cells within the nerve cord occurs (fig. 227). These cells nourish themselves, in part, at any rate, at the expense of the degenerating larval cells, these being always recognized by their great nucleoli and pale cytoplasm which is in process of rapid absorption by the developing nerve cells. In the nerve cord the larval cells lie scattered among the now far more numerous imaginal nerve cells, and large masses of disintegrating cells are also often to be observed (fig. 227). In the brain this is even better seen. The developing nerve cells, it seems, then simply absorb the dead larval cells, growing at their expense, and in the larva some twelve hours after defaecation no trace of the old larval cells remains.

As the nucleated portion of the nerve cells has thus disappeared, the long columnar nerve strand and the fibres which form the peripheral nerves likewise disintegrate. But, the appearances of degenerating nerve fibres in these two regions are quite different.

Within the nerve cord the degeneration of the two nerve strands is so intimately associated with the regeneration of the nervous system that it is impossible, as a rule, to *see*, even with the highest magnifications, what is actually taking place. Sometimes, however, and especially within the brain, this may be seen, the larval nerve strands, as the nucleated portion dies, begin to undergo a total disorganization, and in place of the strands of most delicate, almost microscopically invisible nerve fibres, we now see an irregular clumping together of the fibres and even partial disruption of these Into this degenerating mass now extend newly formed nerve fibres from the recently developed nerve cells. In the larva eight hours after defaecation these give off short processes, which soon become longer and needle-shaped (fig 228). These then extend into the degenerating nerve strands as fibres of extraordinary fineness, and as the old larval fibres degenerate the newly developed processes from the imaginal nerve cells replace them. These events usually run so closely together that it is not possible to observe either in progress; it is only when for some reason there is a delay in the formation of new nerve fibres, as often happens in the brain, that a marked globular degeneration of the nerve strands can be detected.

In the peripheral nerves, however, the process is much more marked, and very fine instances of tissue disintegration in the absence of phagocytes can be observed. In the defaecating larva, as the splanchnopleural covering of the nerve fibres is degenerating and is in process of rapid regeneration (so that no discontinuity exists between the sheaths of the peripheral nerves of the larva and imago), a total degeneration of the contents of these nerve sheaths takes place. The constituent nerve fibres disintegrate, and the products of disintegration unite to form several large oval globules (fig. 223), which, perhaps as a result of the pressure of the sheath, are forced along the nerve, and breaking out, evidently through some point of weakness, float about as small rounded globules in the blood stream. Here they may be in part absorbed by phagocytes and in part simply dissolve in the blood. Towards the end of the larval period the imaginal nerve fibres, which have been growing down and replacing the old larval nerve strands in the ventral nerve cord, enter the emptying renovated sheaths of the old larval nerves. No more profound tissue metamorphosis than this could be imagined, and yet, as far as the gross anatomical changes are concerned, no marked change occurs. It is probably these large globules—degeneration products of the larval nerve fibres—that Weismann observed.

Meanwhile the neuroglia network within the nervous system has been undergoing similar changes. This is especially clearly visible in the larva eight hours after defaecation in the regions between adjacent ganglia. The larval neuroglia cells are observed here forming a loose network of fibres (fig. 229). Some of the cells are clearly in a senescent condition, presenting large nucleoli; some are growing very pale, evidently losing their cytoplasm, while others about them are growing at their expense.

Immediately surrounding the nerve strand is a single layer of very small cells (fig. 227). They appear to be also neuroglia cells, forming a support for the fibres of the nerve strand which they enclose. At the time of defaecation they are undergoing the same changes as are taking place elsewhere at this period. Some of the large nucleoli are degenerating and being absorbed; others are in mitosis, and are evidently going to replace them.

The absorption of larval cells, and the proliferation of the imaginal elements within the nerve cord take place then, at the time of defaecation, and are complete about eight to twelve hours later. But at about the time of pupation other changes which affect the gross anatomy of the ventral nerve cord commence. These are the changes which Newport first investigated, using *Sphinx ligustri* as his subject, and consist in a remarkable migration of ganglia, resulting in the fusion of these in groups to form the concentrated nervous system of the adult.

The regenerated nerve cord is composed of twelve ganglia, connected in front by the circumoesophageal connectives with the brain (figs. 225a, 231). The first ventral (suboesophageal) ganglion fuses with the brain and will be considered in connection with that structure.

A little after pupation the sixth and seventh, and also the ninth and tenth, ganglia fuse, so that the number of ventral ganglia has been reduced to ten (fig. 225c). In the pupa four hours old the eighth ganglion has merged into the fused ninth and tenth, the number being now reduced to nine (fig. 225d). By the fusion of the ganglion of the propodeal (first abdominal) segment with the third thoracic ganglion in the pupa eight hours of age and the absorption, at about this same period, of the eleventh (second last) ventral ganglion into the fused eighth, ninth, and tenth, the number of ganglia becomes finally reduced to seven. As the first ventral ganglion becomes merged into the brain it is no longer recognizable as a distinct ganglion (fig. 225e), and the ventral nerve cord cannot therefore be said to consist of more than six ganglia. In this condition we find them in the imago. The first three are large and lie one in each thoracic segment; connecting the last thoracic ganglion (fused fourth and fifth) with the first abdominal (fused sixth and seventh) is a particularly long nerve strand. The first abdominal ganglion is rather small. The next two, especially the last, are much larger and supply the hinder and ventral region of the abdomen.

I have not observed the cellular activities which underlie these migrations of ganglia; there can, however, it seems, be only one process by which this takes place, *viz.*, by the amoeboid movement of the nerve cells through the fine neuroglia network. It is evidently in this manner that the cells move about within the nerve cord.

In some ganglia the nerve cells may form layers five cells in thickness, these gradually diminish in number at the hinder and front parts of the ganglia and on the nerve strands connecting adjacent ganglia may, at times, be quite absent.

In the stomatogastric ganglion a destruction of larval elements, followed by a development of imaginal nerve cells, similar to that seen in the ventral nerve ganglia, occurs. It is unnecessary to refer further to it here.

It will be useful to point out that the apparent absence of metamorphosis in the nervous system (except for the migration of ganglia), which is usually supposed to occur in insects, has never yet been demonstrated. Even Weismann's observations on *Corethra* do not wholly disprove it, the destruction of larval cells on a small scale being impossible to detect in hand dissections.

The most noteworthy feature of the metamorphosis of the ventral nerve cord is, then, the spontaneous degeneration of larval cells, and their destruction not by leucocytes, but by a gradual process of absorption by the growing nerve cells.

An average sized nerve cell from the imago measures not more than 5μ in diameter, though at times quite large cells, as much as 12μ by 8μ may be seen. The cytoplasm is usually much reduced, most of it having entered the nerve fibre process. At times a small, or rarely very large, nucleolus is seen.

The splanchnopleural nerve sheath may be seen to be continuous, at the termination of the nerves among the organs, with the walls of the cells on which the nerve ends (fig. 226).

The Brain.

While it will often be possible in the following description to refer to the nerve tracts within the brain, it is manifestly beyond the scope of this paper to make any attempt to elucidate the actual nerve connections.

The brain of the newly hatched larva (figs. 1, 230) is a very prominent structure in the form of two large hemispheres occupying the greater part of the second head segment, and projecting forwards into the first. It measures about ·15 mm. from side to side in its broadest region, and is connected with the first ventral ganglion by a pair of short, thick, circumoesophageal connectives, which pass backwards and downwards and enclose between them the oesophagus (fig. 231).

The brain at this early stage is not in a very advanced condition, and it may be divided into two parts, an inner functional region and an outer region, in which active functioning does not evidently occur (fig 230). The functional (truly larval) portion of the brain consists of a mass of nerve cells, occupying a great part of the interior of the brain. The individual nerve cells *appear* to be quite small, seldom more than 5μ in diameter; this is due to the fact that most of their cytoplasm is to be found in the long nerve fibres, whose volume it is not possible to estimate accurately. They have a faintly granular nucleus, the usual karyosome is very small or often quite absent.

The fibres from these nerve cells all converge to form a pair of great nerve tracts, one on either side, within the brain, and these great nerve tracts are joined by a very narrow tract from the inner portion of the antero-ventral brain region—from the antennal ganglion. Other nerve fibres from this antennal ganglion unite to form a very minute nerve which terminates on the pair of minute sense papillae (true antennae) of the first segment. In this region, and also within the great central mass of nerve tissues, synapses must occur in great numbers, but I can say nothing definite about them here. Some of the nerve fibres in the brain cross to the opposite side, others form strands which travel in various directions. From the brain numerous other fibres collect to form the two circumoesophageal nerve tracts, which connect the brain with the ventral ganglia.

Forming a distinct layer on the outside of the functional nerve cells are the neuroblasts, evidently non-functioning cells at this period of development (fig. 230). They are 8μ to 9μ in diameter, and have the "vesicular" type of nucleus with its large karyosome, so commonly found among undifferentiated cells. Though they appear to be larger than the functional nerve cells, this is in reality not so, most of the cytoplasm of the latter being found in the long nerve fibres; in this respect, then, they form no exception to the rule that the functional larval cells are always much larger than the non-functional imaginal cells, which will replace them during metamorphosis. The neuroblasts form especially well-developed areas in certain parts of the brain: there is a pair of very well-defined layers, in places swollen into large masses, on the outer lateral regions, constituting the anlagen of part of the two optic ganglia (fig. 230). They extend round partly behind the brain as large bowl-shaped structures and give off forwards each a small mass of cells which projects into the brain amongst the larval cells, towards the great nerve tract, and seems to constitute the "bourrelet intraganglionaire" of Viallanes. On the internal postero-dorsal portions of the brain are two pairs of masses composed of rather small imaginal neuroblasts; they are the anlagen of the four ocellar ganglia. There is another cluster of imaginal cells lying one on the anterior ventral part of each of the large hemispheres near the larval ganglia and representing the cells from which the antennal ganglia of the adult will later develop (fig. 230).

During the period of active growth of the larva there is the usual increase in size of the purely larval elements in the absence of cell division. The neuroblasts do not, so far as I can observe, undergo any division during this period. But at the end of this period of activity (fourth day of larval life) the metamorphosis commences, at first slowly, but a day later (at the time of defaecation) with apparently much greater rapidity.

When the brain of the larva in the defaecation period is examined in sections the cells which constituted the functional part of the brain during larval life are seen to be in a state of advanced degeneration (figs. 77, 78, 235). The cells are small and highly granular; nuclei are visible often only with difficulty; large nucleoli are usually present. Sometimes the cell outlines are already becoming indistinct and the whole mass is obviously in a state of active disintegration. Leucocytes have not been able to penetrate to these cells, and histolysis is entirely of a non-phagocytic nature. The great nerve tracts also show obvious signs of degeneration at this same time; distinct fibrillation of the tracts gradually disappears, and sometimes a faint indication of degeneration into fatty and other globules becomes manifest. But visible degeneration in the areas, whose structures in the living state is difficult enough to observe, is never so pronounced as in the surrounding areas where the nerve "cells" are dying.

Contemporary with this extensive cellular degeneration a pronounced activity of the neuroblasts is to be observed. In the defaecating larva the neuroblasts have already greatly proliferated by mitosis, and active mitosis in various parts is still to be observed, especially in the anlagen of the optic ganglia (fig. 235). And as these cells rapidly increase in number they nourish themselves in part upon the dead masses of nerve cells and nerve fibres, and growing gradually in bulk in the larva eighteen hours after defaecation, absorb and replace these altogether. The cells of the two pairs of ocellar ganglionic anlagen proliferate rapidly. Similar changes occur in the imaginal cells (neuroblasts) of the antennal ganglion. In the larva at about the time of defaecation, two kinds of dividing cells may now be clearly distinguished: there are—*(a)* the large rather strongly staining cells which form the various ganglia and the "bourrelet intraganglionaire" ("Zweite Bildungsherde" of Bauer), and *(b)* a great mass of more rounded paler cells sometimes still seen in mitosis and forming the greater part of the imaginal brain where the great ganglia do not occur. A small group of these is to be seen between the optic ganglion and the zone of degenerating larval cells, into which they project. It is possible that these constitute a mass of neuroglia cells; the proliferation of others which form a great ring around the bases of the two hemispheres in the neighbourhood of the ocellar and antennal ganglia, is resulting in a gradual constriction of the great central mass of degenerating nerve fibres here *(cf.* fig. 232, x).

In the larva eight hours after defaecation a small mass of cells, often in active mitosis, appears outside the extremity of the degenerate nerve strand. It seems to be formed as an ingrowth from the optic ganglion and constitutes the "bourrelet perilaminaire" of Viallanes, the "(Erste) Bildungsherde" of Bauer (fig. 232 o.g.2).

From the simple anlage of the optic ganglion three masses of cells therefore arise:—

(1) Those which form what I shall call the *outer optic ganglion*, whose fibres communicate with the compound eye. It is that part of the primitive anlage which remains when the other two parts have been formed from it, and occupies the position of the "optic ganglion," as I have referred to it above (o.g. in figs. 80 and 236).

(2) Those which form the *middle optic ganglion*, as I shall call it, and are represented by the "Bourrelet perilaminaire" of Viallanes. This mass first becomes visible in the larva some eight hours after defaecation (o.g.2 in figs. 80, 232, 236).

(3) Those which will form the *inner optic ganglion*, and correspond to Viallanes' "Bourrelet intraganglionaire" (o.g.3 in figs. 80, 232, 236).

During larval life there is a continued growth in the size of the brain, but it is in the last few hours that it begins to assume its adult appearance. This takes place in three ways: *(a)* by the gradual change in shape of the optic ganglia, *(b)* by the development of nerve fibres and synapses, *(c)* by the gradual incorporation of the first ventral (sub-oesophageal) ganglion.

Towards the end of the larval period the cells comprising the outer optic ganglion begin to migrate outwards in the meshwork of fibres formed by the perioptic membrane (see

Organs of Vision), and this gradually results in the change in shape of the whole optic region, till eventually in the three-day pupa the optic ganglion is mainly in the form of a short stalk which connects the eye with the rest of the brain, while the other two optic ganglia lie in a projection of the hemispheres rather narrower than that in which they lay in the adult larva (figs. 80, 234, 236).

In the early pupa, too, the antennal ganglia grow largely in size (fig. 232), and form a pair of very distinct antennal lobes projecting downwards, forwards, and slightly inwards from the antero-ventral part of each hemisphere. The ocellar ganglia also project slightly on the surface of the brain.

In the last hours of larval life a development of the nerve fibres has commenced. This is rather difficult to observe, for the newly formed nerve fibres grow into the degenerate mass of old nerve fibres, absorbing them as they grow, and as the latter disappear, the others replace them, there being no visible discontinuity. The only visible sign of change is a gradual resumption of fibrillated appearance by the degenerate masses of nerve strands. The new nerve strands thus formed are best studied in the optic region. Between the outer and middle optic ganglia such a strand, rather short and thickset, and never very prominent, gradually appears, quite independently, in this case, of the old larval nerve strand. It corresponds to the *perioptícon* of Hickson (figs. 80, 236), and is formed by fibres some of which have grown inwards from the outer ganglion, others outwards from the middle ganglion. Synapses are doubtless formed between the two.

The nerve cells comprising the middle and inner optic ganglia likewise develop fibres, which grow, this time, through the old larval nerve strand. They evidently form synapses here, and the whole structure forms the second mass of nerve fibres, very well developed in the imago, and constituting the "epiopticon" of Hickson (fig. 236). The nerve cells of the inner ganglion likewise give off processes inwards along the old larval nerve strand, and they and similar fibres from more internal parts of the brain unite to form the "opticon" of Hickson—the third optic nerve strand, which finally brings the optic nerves into communication with the rest of the brain. These changes take place in the early pupa, and so far as it is possible to *observe* them, are complete at the end of about the first day of pupal life. Many of the cells thus produced are true bipolar nerve cells, but many of the fibres which help to form these large nerve strands come from masses of cells which have not grown into the brain, but have remained more at the periphery. Although I have not been able to observe them directly, it would seem that the fibres should be of the T-shaped type.

Meanwhile the two antennal ganglia have been increasing in size The cells in the early pupa send out processes along the degenerate antennal nerve tract of the larva, and as the latter is gradually absorbed the fibres of the former develop at its expense. The fibres from the antennal nerve pass inwards into the antennal lobe, and within it meet and evidently form synapses with other fibres given off from cells in the more dorsal parts of the antennal lobes, these fibres in turn passing backwards and upwards as a short, thick, nerve tract which enters the great irregular mass of nerve fibres in the middle of the brain (fig. 234). This "white matter" of the antennal ganglion is a very large and rounded mass of fibres showing shallow clefs on its surface.

Meanwhile the great mass of paler cells described above has continued to grow; the cells encroach more and more upon the great degenerate nerve strands of the larva at the base of the two hemispheres in the region between the antennal and ocellar ganglia (fig. 232x); and shortly after the first day of pupal life, continuing to absorb the whole larval nerve strand without proliferating, so far as I could observe, any more, gradually replace this, and as nerve fibres from these and other cells lying more on the periphery grow into the dead nerve strand, this is finally absorbed and replaced by the fibres from the imaginal cells. These fibres seem to communicate with others formed from the inner optic ganglion and the resulting structure is the "opticon," as Hickson has called it in *Calliphora*.

By this means, then, the larval brain is gradually transformed into that of the adult. Phagocytes play no part in the process of absorption, but the dead cells serve directly as food for the growing imaginal cells. And although the presence of mitotic figures within the brain is the only clear sign that development is going on at all, yet when a more careful study is made it is soon seen that the brain undergoes as profound a metamorphosis as does any other organ of the body.

Meanwhile the first ventral ganglion has gradually become incorporated into the brain. In the fresh pupa, although "rejuvenation" of the ganglion has taken place, like most of the other ganglia of the ventral chain, migration has not yet commenced. But shortly after pupation the cells or the ganglion begin to migrate upwards along the circumoesophageal connectives (fig. 232). In the twenty-six hour pupa they have definitely become a part of the now very complex brain fig. 233), and during the next day they begin to consolidate their position, and spread themselves more evenly over large parts of the postero-ventral part of the brain. From this region at least three pairs of nerves are given off to the mouth parts, so that this part of the brain may be said to constitute a distinct lobe—the *oral lobe*.

The nerve cells comprising the brain are of the same type as those of the ventral nerve cord; dendrites are present, though usually very hard to see (fig. 224) The cells vary from $3\frac{1}{2}\mu$ to 7μ in diameter.

According to the investigations of Bauer (1904) the nerve cells, and even individual ganglia, are developed from *single* neuroblasts, which bud off daughter cells, which after dividing once become transformed into nerve cells. In *Nasonia* this does not appear to be the case. The single-celled neuroblast stage is passed through in the very early embryo, and in the larva of the first instar the various ganglia are already to be seen as distinct accumulations of embryonic cells.

THE VASCULAR SYSTEM.

(a) The Blood.

The blood is the great essential tissue which co-ordinates the whole process of metamorphosis. It is the medium in which the processes of destruction and regeneration occur; into it the dying cells cast their products of degeneration, and upon its substance the growing tissues nourish themselves.

This has been made abundantly clear in the description of the metamorphosis of the various organs; the actual chemical changes, however, which go on in the blood cannot be discussed here. It is sufficient to say that the globules and granules into which the various larval organs degenerate are to a large extent cast into the blood stream, where they dissolve. The blood, in consequence, which is usually quite "thin," becomes during the late hours of larval life, and the early hours of pupal life, very "thick," and so heavily laden with protein materials that it often stains very strongly in preparations and appears as a structureless matrix in which the other organs lie suspended. But as the imaginal organs develop, these substances gradually disappear, and are no longer visible a day after pupation.

Frequently, however, the dead larval tissues do not have time to dissolve in the blood stream; the leucocytes, instead, assuming their important *rôle* of body scavengers, fall upon the dead tissues and rapidly absorb them. This phagocytic absorption of dead tissues is very clearly seen in the removal of the salivary glands, of certain tracheoles (fig. 88), of the temporary pupal midgut (fig. 153), of certain muscles (fig.

105), and to a less extent in certain other tissues—processes which have all been described above. Nevertheless, if these tissues are inaccessible to leucocytes, as often happens, for example, through the pressure of the fat-body, then phagocytosis does not occur, and the tissues undergo a gradual solution in the blood (fig. 91, trl.).

Weismann (1864) was the first to observe tissue disintegration in metamorphosing insects. He regarded the tissues as breaking up into minute globules, "Körnchenkugeln," and to the process he gave the name *histolysis*. In 1884 Van Rees, and in the following year Kowalevsky, stimulated by Metchnikoff's great discovery of the phagocytic activity of leucocytes, put a special interpretation upon Weismann's "*histolysis*"—they regarded it as a tissue phagocytosis, the "Körnchenkugeln" being the gorged leucocytes.

Berlese (1901) has wholly denied the existence of phagocytosis of living tissues; while Pérez (1910), working with *Calliphora*, regards the leucocytes as playing the main part in the destruction of larval tissues. In *Nasonia* there can be no doubt that chemical disintegration, and phagocytosis of dead tissues, both occur. The phagocytosis of dead tissues is, however, not so ingenious a device for the removal of *débris* as it at first sight appears to be; a more direct process would obviously be the solution of dead material in the blood. That this can occur in tissues which are phagocytised only when leucocytes have special access to them has been clearly demonstrated in the case of the tracheoles, and phagocytic histolysis is to be looked upon as the sign of a not yet fully evolved metamorphosis—of an imperfect though ingenious method for attaining a result—which will be perfected only when the tissues have "learned" to dissolve directly in the blood stream, and the leucocytes, in their turn, to refrain from attacking these as they disintegrate. Berlese believes he has observed this kind of metamorphosis in a number of insects, but there is little doubt that he overlooked a quite extensive phagocytosis of larval tissues. It is only when other metamorphoses, especially those of highly specialized insects, are investigated, that an "ideal" transformation may be discovered. Phagocytic histolysis of larval tissues, indeed, seems to be a very much over-estimated factor in the mechanism of the insect metamorphosis, and although some investigators, *e.g.*, Verson, regard it only as a removal of *dead* larval tissues, others believe the leucocytes to be endowed with far higher powers and that they destroy the larval tissues while these are yet capable of actively functioning; Metchnikoff inclined to this view, and more recently Pérez (1910) has written in its favour. I shall discuss it more fully in the second part of this paper, and shall merely remark here that this view is quite untenable.

The leucocytes of the larva in its first instar are not very numerous; they are about 5-7μ in diameter, and like most of the tissue cells at this stage have a fairly hyaline cytoplasm and a clear nucleus containing a large karyosome. They are visible through the transparent cuticle and usually lie very still. They do not grow in size during larval life.

Their function during this period is apparently to engulf any bacteria which may have entered the circulation, and I have been able to observe them in young transparent larvae lying quite still in the blood, and absorbing minute bodies (micro-organisms ?) which were floating about in it. They are not, however, called extensively into activity till a little after feeding ceases. At this time the disintegration of larval tissues begins; and although the dead and dying larval cells are not bodily attacked till a day or two later, yet an absorption of their products of degeneration (globules and granules which have failed to dissolve) may occur. This period is marked by a great increase in the number of leucocytes, and during the next forty-eight hours their proliferation becomes very extensive.

At first the leucocytes content themselves with absorbing stray granules and globules cast out by the degenerating cells, but later, especially at the end of the time of pupation, they fall upon the dead larval cells which have not yet disappeared and rapidly remove them. The process has been described above in the various tissues and need be only briefly mentioned here. As a rule, it seems, the leucocytes do not enter the cells which they are attacking, as occurs so markedly in *Calliphora*, but, attaching themselves to their walls, send in a pseudopod, which gradually spreads out within the disintegrated cell, and an absorption of its substance commences (fig. 129). It is only rarely in *Nasonia* that a leucocyte bodily enters the larval cells. At other times the leucocytes content themselves with nibbling off small pieces of tissue, which accumulate in small rod-like or rounded structures within their cytoplasm (fig. 195); at times, however, a leucocyte may tear off long shreds of tissue. So large may these be that, to be accommodated within the leucocyte, they have to be bent and twisted about (figs. 197, 199).

Division of the leucocytes appears to be only by binary fission. At times fully gorged leucocytes divide; but the engulfed food always descends to only one of the resulting cells (fig. 196). I could not observe any cases of mitotic division.

The fully gorged leucocytes, which may be as much as 11μ in diameter, begin to accumulate during the last hours of larval life, and the early stages of the pupal period within the cavities of the various appendages A digestion of their engulfed food occurs here, and soon the food is recognizable only as a number of large rounded or irregular granules within the cytoplasm of the leucocytes (fig. 204). Large vacuoles develop (fig. 194)—structures related perhaps, in some way, to digestion of the granules, and these vacuoles are already quite commonly seen while the leucocytes are still actively engulfing food. Within the cavities of the appendages these vacuoles may increase greatly in size and considerably distend the leucocyte. Frequently the distension is so great that the leucocytes burst (figs. 205, 206), and their nuclei and degeneration granules float about in the blood stream and finally dissolve. Usually, however, the leucocytes succeed in digesting their meal and gradually diminish in size again. The granules slowly disappear, and only small vacuoles remain (figs. 208, 209). In this condition they persist throughout the life of the insect. They are about 7μ in diameter, and have a large nucleus, with a faintly granular chromatic content, and one small karyosome.

(b) The "Heart."

The fate of the heart during the insect metamorphosis has, so far as I am aware, never been carefully investigated, and the most contradictory views are held as to the events that occur within it during this period.

According to Newport, the dorsal vessel of *Sphinx ligustri* pulsates throughout the whole of the pupal period, and evidently undergoes no changes during this time. In *Eristalis*, on the other hand, Künckel d'Herculais observed a cessation of the heart beat for one or two day's after the eighth day of pupal life.

According to Kowalevsky (1887) the dorsal vessel in *Calliphora* pulsates regularly till the third day of pupal life; thereafter it beats more irregularly, but does not seem to undergo any metamorphosis. Lowne (1890-1895) partly inclines to this view; he observed a change in the form of the heart, but attributed this to a possible replacement of its old muscle cells by new ones.

Weismann (1864), with no modern technique available to him, came to an entirely different conclusion. He observed, in hand dissections (!), that the heart became more fragile and was evidently at this time in a state of "histolysis." "As an organ it is not broken up, but is redeveloped by a process similar to that which has been observed in the intestines and malpighian vessels."

If the transformation of the heart of *Nasonia* is any indication of what happens in the blow-fly, then there can be no doubt that Weismann's view was the more correct. In the heart of *Nasonia* a metamorphosis occurs quite as profound as that observed in any of the other organs.

The Structure of the Larval Heart.

The heart of the larva (fig. 211) is a long tube, running right along the mid-dorsal region of the body and gradually bending downwards near the middle of the body, terminating in front, close behind the brain. It measures about 1·6 mm. in length. It is widest behind, where it measures ·08 mm. in diameter and gradually tapers in front into a long capillary tube—the "aorta."

The heart lies within the pericardium, a tube composed of a fine delicate membrane (fig. 213), which opens just behind the posterior part of the heart by a large funnel-shaped opening (figs. 211, 212), and tapers gradually anteriorly, eventually fusing in the anterior part of the body, with the heart. The pericardial walls are composed of a single layer of greatly flattened cells (fig. 213), but are quite devoid of muscles.

While the pericardium has a wide funnel-shaped opening into the body cavity behind, the heart itself is closed, and has no communication with the pericardial cavity except by a series of six pairs of minute openings, the ostia. These ostia are usually very difficult to observe, the only prominent ones being a single pair at the posterior end of the heart (fig. 212). The cardiac walls are here deflected inwards to form a valve, which allows blood to flow only from the pericardial cavity into the heart.

Neither the walls of the pericardium nor of the heart are themselves contractile; pulsation of the heart is produced by the contracting of certain very delicate muscles inserted in the walls of the heart in irregular pairs at intervals along its length; the other ends of these minute muscles are inserted directly on to the dorsal integument. The pericardial walls are drawn out into long conical processes, within which these muscles lie (fig. 211). So far as I could observe, the pericardium is itself not contractile, and alary muscles appear to be quite absent. The pericardium, then, appears to be different from what is supposed usually to occur in insects.

The cells of the heart undergo the same changes during larval life as do those of the other specialized larval organs; there is a great increase in cell size, with a total absence of cell division. In the adult larva they have attained a great size (fig. 216); they are very flat and measure as much as

34μ in length. The nucleus is rounded or oval, measuring 5μ by 12μ, and has a small nucleolus

The Metamorphosis of the Heart.

It is at about the time of defaecation that the heart begins its transformation, and the metamorphosis is very profound. In the period just prior to defaecation the pericardial and heart cells begin to undergo a granular degeneration. The nuclei show the usual great nucleoli, and the cells the usual hypertrophy (fig. 214) At this time it becomes possible to distinguish clearly the larval from the imaginal elements within the heart tissues (fig. 213). The imaginal heart, however, is regenerated not only from scattered embryonic cells within its walls, but also from a mass of embryonic cells lying just below the heart, and dorsal to the rear of the midgut. I have not been able to locate this structure in the early larva, but at the time of defaecation a column of these embryonic cells may be observed extending upwards and along the ventral side of the pericardium. Proliferation is very rapid and the cells advance quickly, absorbing the larval elements as they grow (figs. 214, 215, 216). The heart itself is rejuvenated mainly or entirely from the imaginal cells within its walls; only the pericardium seems to arise from the "sub-pericardial imaginal disc." In the larva eight hours after defaecation the heart tube has been completely rejuvenated, and below it, and in close contact with it, lies a long band of cells, the renovated "pericardium" (fig. 217). The nuclei of the (true) heart cells are large and bulge into the lumen of the tube (figs. 217, 219). At this period the imaginal pericardial cells are in process of rapid division. They quickly grow upwards (fig. 218) and soon form another tube on 'the outside of, and in close contact with, the renovated heart. The pericardium, therefore, no longer forms a loose sac on the outside of the heart, but actually becomes a part of it (fig. 219). In the region of the stomach the "compound" heart remains as a rather wide sac-like tube. Ostia become developed, but I have not observed their disposition accurately. In this region, also, the "pericardial" cells, which have formed a membrane in close contact with the true heart tube, transform themselves into striated muscle cells (fig. 220). This part of the heart alone is contractile. All the more anterior part *(i.e.*, in the thoracic and anterior abdominal regions) is to be looked upon as an "aorta." It is composed, of course, of the ordinary heart tube, and the surrounding *closely fitting* renovated pericardium (fig. 219).

The dorsal vessel of the adult wasp consists, then, of a short contractile chamber lying in the posterodorsal region of the abdomen; it alone is contractile, and is not surrounded by pericardium. Its walls consist of two layers, an inner exceedingly fine and delicate "endothelium," the transformed larval heart; and an outer layer of broad striated muscle fibres, circularly disposed, corresponding and homologous with the pericardium. The aorta, which is continuous with it in front, gradually bends down, and lies just dorsal to the oesophagus (*cf.* fig. 154). It is, of course, composed of the same two layers (fig. 219).

During larval life a few large rounded cells lie in close connection with the heart. They resemble the cells of the dorsal abdominal glands in appearance. So far as I could observe, they disappear late in pupal life.

As the thoracic intestine, some six hours after pupation, begins to assume its almost insignificant proportions, the anterior part of the heart (aorta) sags downwards, and comes to lie just dorsal to the oesophagus, *i.e.*, a little below the mid-region of the thorax.

I have not been able to observe the heart-beat during metamorphosis, the heart being too obscured by the surrounding fat-body. In the head of the pupa, however, movements of the fat-body regularly occur, and this is due, doubtless, to the beating of the heart.

Appendix.

THE DEGENERATION PROCESSES OF THE LARVAL CELLS OF *NASONIA*.

The physiological interpretation which we place on the insect transformation depends in the main on our knowledge of the condition of the larval cells at the time of metamorphosis. Do the cells die, and is it only dead material that the leucocytes absorb; or are they attacked by the leucocytes while still alive? It is the former opinion, to a certain extent, that Berlese holds: "Phagocytosis never occurs, and amoebocytes only become active when the muscle has disintegrated through internal causes." His amoebocytes were, mainly, at any rate, embryonic cells—"Myocytes," "Splanchnocytes," etc.—but there can be little doubt that his "sarcolytes" were really gorged leucocytes, and that phagocytosis does occur is certain. But is it phagocytosis of dead or living larval cells?

Pérez has written in favour of the latter view. "I think I have proved satisfactorily that there is no spontaneous fragmentation of this organ into sarcolytes, as Berlese thought." He observed the phagocytes entering muscles always of apparently normal structure But at other times he was clearly dealing with degenerating cells—cells with globulated and highly vacuolated protoplasm, though the occurrence of large vacuoles in the living salivary glands led him to doubt this interpretation. It should be pointed out, however, that even if a cell still has its normal structure, that is no proof that it is not dead. It may take many hours for the structural symptoms of death to become visible It is, perhaps, just necessary to add that in whatever condition the tissues may have been when they were fixed, there is no doubt that when they were examined they were dead. It is also worth drawing attention to the fact that Lowne has expressly stated that the larval muscles become functionless some time before phagocytosis commences The muscles of *Calliphora* appear to be very resistant to autolysis; torn-off fragments engulfed by phagocytes still retain their normal structure, yet these are, it is to be presumed, quite "dead."

When, however, we examine the cells of the adult larva of *Nasonia* no doubts can be left in our minds that death, accompanied this time by active disintegration, has occurred, and the most varied types of disintegration are to be seen. All the cells show as a common feature a great hypertrophy. They have often grown to many times the size of the cells of the newly hatched larva; even the nerve cells have grown greatly, though here the increase in size cannot be estimated, as the volume of the nerve fibres is indeterminable. Most of the degenerating cells present, also, a great nucleolus within the nucleus. Sometimes this may be relatively gigantic and may lodge excretory (?) crystals. This in itself lends support to the view that the nucleolus is a structure within the nucleus concerned with excretion—perhaps itself an excretory product, perhaps an excretory "organ."

The disintegration of the various cells occurs, as we have seen, in many ways. Sometimes before this has had time to proceed very far, phagocytes or embryonic imaginal cells may overwhelm them (many muscles). At other times the adjacent imaginal cells absorb the degeneration products of the dead larval cells directly, either by secreting an enzyme which dissolves them, or by waiting for them to disintegrate spontaneously (microscopic examination cannot decide between these two). This is seen in the nerve cells.

But at other times the larval organs undergo most marked visible disintegrations. The cytoplasm becomes disorganized and may break up into globules or granules, or into a very fine *débris*, and be cast, as one large globule, or numerous minute particles from the cell, the wall of which itself later dissolves in the blood stream or is absorbed by phagocytes. One of the commonest sights in the pupa is the hulks of these old cells, usually quite devoid of any trace of cytoplasm or nucleus, floating about in the blood stream, waiting to be engulfed by phagocytes. Sometimes the muscles may disintegrate spontaneously and may break up gradually into small globules which break through the sarcolemma and dissolve in the blood or become phagocytised; but perhaps the most extraordinary case of spontaneous disintegration is seen when the whole of the minute rod-like sarcous elements, which comprise the striations, are cast as a shower of minute particles into the blood, where they gradually dissolve (fig. 104).

At no time have I ever observed the phagocytosis of tissues which could be regarded as living, and even in those cases where embryonic histoblasts overwhelm the larval organs and develop at their expense, visible degeneration has always previously occurred.

Part II. On the Physiology and Interpretation of the Insect Metamorphosis.

The constant occurrence of so many different characters, often of the most trivial kind, amongst even the most widely separated orders of insects, is in itself sufficient evidence to show that the "insect type" must have been evolved before the many varied kinds of development which we see at the present day amongst insects, existed. It is inconceivable that such organs as compound eyes, wing nervures, insectan mouth appendages, legs of a constant character, to mention but a few of them, should have been produced again and again from independent sources.

Nor is it difficult to decide whether these primitive insects showed the direct or the more complicated type of development. The oldest insects yet discovered—the Palaeodictyoptera and Protorthoptera of Carboniferous times, were clearly related to insects which at the present day show no metamorphosis. The discovery in the Permian rocks of Russia of an ephemerid type of larva shows that already at this early period the indirect type of development, though as yet not of a very profound nature, had begun to evolve. There can be little doubt, however, that when the insects which must have existed in the earlier Palaeozoic ages become known to us, none but the most generalized of types will be found to have existed. It may, of course, be said that insects of a kind which now undergo no metamorphosis may have done so at an earlier period; there is, however, no need to make this assumption, for, as I shall show later, the evolution of metamorphosis has been a necessary consequence of the specialization which these early generalized orders have since undergone.

In order to trace the stages through which metamorphosis has been evolved it will be necessary to describe, very briefly, the main features of the postembryonic developments of a number of insects, in so far as we know them. As many of the accounts are not very reliable, and as no metamorphoses have been investigated from this point of view, the comparison is less complete than it ought to be. The insects are arranged in what I regard as ascending degrees of metamorphosis. The reason for this will be clear later. It is very interesting, at the same time, to observe that the order is also *approximately* that of increase of specialization.

(1) *The Aptera.*—These emerge from the egg in practically the adult condition. In *Machilis* the eye is believed to continue to develop. Sexual organs undoubtedly ripen during post-embryonic life.

(2) *Orthoptera and Hemiptera.*—These usually emerge in a condition which, though like that of the adult, is somewhat more generalized, *e.g.*, the thoracic segments have not yet markedly differentiated. During post-embryonic life there is a gradual growth of the wings; the insect moults several times, but only at the last moult do the wings appear free on the surface. Sexual organs undergo a parallel development. In the wingless forms post-embryonic life is of the apteran type.

(3) *Odonata.*—Partially developed wings clearly visible through the integument, even in early instars. Legs always very well developed, resembling those of adult. "The internal metamorphosis begins considerably before the hatching of the insect; the larva refuses to feed and is restless. Hypoderm cells proliferate, causing the larva to appear tense and swollen. The wing muscles grow greatly and increase the size of the thorax. New elements form rapidly in the eye."—Tillyard (1917). The larva then leaves the water, and the moult discloses the adult insect. Nothing is known of the cellular changes underlying the process, but they are evidently of the highest interest.

(4) *Coleoptera* (type: *Galeruca*, examined by Poyarkoff). —Larvae emerge with typical insect head and mouth appendages. Legs present, but much more reduced than in *Odonata*. Wings never clearly seen in larva. Division of

purely larval cells occurs during the feeding period, and there is a great growth in size. At metamorphosis some of the more specialized tissues (muscles) are phagocytised (evidently after dying); the cells of the less specialized tissues (hypoderm, oesophagus, rectum) cast out parts of their substance, and having evidently rejuvenated, remain as the adult tissues. In the case of the other organs, those of the imago are formed from areas of cells which till now have lain dormant—the imaginal discs.

(5) *Lepidoptera.*—Larvae emerge with typical insect head and mouth appendages. Legs present though very reduced. The larval cells divide just before the various moults during the larval period. The larval tissues seem to disappear by phagocytosis and redevelop from imaginal discs. Very little is known, however, about the Lepidopteran metamorphosis.

(6) *Muscidae* (Weismann, Kowalevsky, Van Rees, Pérez, and others).—The larva emerges as a legless maggot, with reduced spiracles, and with poorly developed mouth appendages. Except for a tracheal proliferation cell division does not occur during larval life. At the end of the feeding period the larval cells die and are phagocytised; the imago develops from imaginal discs of scattered imaginal cells.

(7) *Chalcid Wasps* (type: *Nasonia).*—The larva hatches in a very primitive condition; the head is still in a bisegmented state; the only mouth appendages present are rudimentary mandibles; malpighian tubes have not yet developed; the proctodaeal invagination has not yet even opened into the archenteron. There is no cell division during larval life, except possibly in the tracheal system (most of the apparent proliferation here is, however, due to growth in cell size). After three days all the larval tissues—even the almost insignificant peritoneal membrane—having grown in cell size, die. Some are removed by phagocytes, others dissolve in the blood. The imago develops from imaginal discs or scattered imaginal cells.

It seems to follow from the above account that a metamorphosis—a period of more or less violent transformation in contrast with "normal" progressive development—occurs in its simplest form in the dragon-flies. No definite pupa is formed here, and the insect, though restless and refusing to feed, is never helpless. But in all the others the internal changes are of a much more violent nature, amounting at times to an absolute death—in the fullest sense of the word—of the larva. If imaginal tissues were not present the "corpse" would be left to decompose; the imaginal cells, however, take the opportunity, and nourishing themselves upon the highly nutrient material of the dead larva, grow by an orderly process of development into a totally different organism —the imago. Even the instincts of the metamorphosing larvae are those of dying animals—they avoid the light; they roll themselves up in leaves; they crawl into secluded spots, or, significantly, even bury themselves in the earth! And yet by a wonderful process of development, unique of its kind among living things, the dead larva becomes the prey of minute scattered cells which have lain helpless among the larval cells while these flourished; having awaited their opportunity, these now spring into activity, and nourishing themselves upon the bodies of the dead larval cells, form another organism. From the grave of the dead larva arises the perfect insect.

While then in the simpler metamorphoses there is a rapid transformation of tissue, in the more profound type a serious disruption of tissues occurs, the embryo developing within the old larval sheath is in a helpless condition, and we speak of it as the pupa.

The metamorphosis of an insect consists, therefore, of two processes—a process of disruption and a process of orderly embryonic development. A "complete" explanation of metamorphosis will, therefore, have to account for the disruption and likewise for the orderly development which ensues. The mechanism of the development is identical with that of any other embryonic development; it is the unexplained "Entwicklungsmechanik der Organismen," and I can say nothing of it here. For the process of disruption—of actual transformation—however, a simple explanation may, I think, be given. As it is highly probable, moreover, that the factor which brings about disruption of larval tissues in the more complex metamorphoses is identical with that which forces the cells in a simpler type to rejuvenate, it should be possible to obtain a general principle underlying metamorphosis. And lastly, since the rejuvenation of individual cells is itself evidently a process of rapid differentiation in cells in which the process has for some reason become temporarily suspended, it would seem that the same principle should be responsible for the cell differentiation seen in "normal" embryonic developments. The discovery of the mechanism of metamorphosis ought, therefore, to lead to a more general theory of cell differentiation.

As the principle is most clearly revealed in the more profound metamorphoses such as that of *Nasonia*, or the Muscids, these will be considered first. In the section on cell degeneration in the larval tissues of *Nasonia* I have pointed out that phagocytic histolysis consists always of a removal of *dead* tissues by leucocytes or their absorption by embryonic cells, if these cells do not intervene, the dead tissues will dissolve of their own account in the blood. All attempts to explain metamorphosis, therefore, which have concerned themselves with the phagocytosis of *living* tissues, have proved unsuccessful. Metchnikoff, for example, in seeking to explain the immunity of the imaginal cells at a time when the larval cells, which had but a day before been in the height of their activity, were becoming overwhelmed by leucocytes, concluded that the imaginal cells must emit substances which held the leucocytes at bay, and that the larval cells at metamorphosis no longer did this. He was led to this conclusion by his belief in the existence of anti-leucocytic substances in virulent anthrax bacteria which were not phagocytised.

Of the death of the cells before phagocytosis there can, however, be no doubt. While this view has more than once been favourably accepted, the cause of the extensive cell-death has not, so far as I am aware, been satisfactorily explained, and this, after all, is the real mechanical principle that underlies metamorphosis. It is usually believed that the extensive cell-death has been produced by the "wearing out" of a great number of cells all at one time. Such wearing out of cells is believed to occur also in other organisms, but here it is gradual, and as some cells die others replace them. The latter must then be the imaginal cells of the metabolic insect, and metamorphosis has been evolved by the dying cells all "learning" to undergo senescence at one moment; this has evidently been evolved in response to the necessity for a metamorphosis in animals whose young and adult stages have different feeding habits (Lubbock).

Now this explanation is clearly not very satisfactory; if the extensive cell-death is merely a concentration, at one moment, of the deaths of numerous cells which would normally take place gradually throughout the life of the insect, how are we to explain rejuvenation of cells in metamorphoses of a simple type? Metamorphosis by cellular rejuvenation would rather appear to be a stage intermediate between a simple development and a total disruption followed by redevelopment from imaginal cells, as seen in the more profound metamorphoses. Moreover, the essential thing to show would be *how* this concentration of death points has been produced, and this is manifestly beyond the scope of modern cytology.

The extensive tissue disruption, it seems to me, is to be explained on a much simpler principle. The larva consists, in the highly specialized forms, of very specialized cells. Such cells never proliferate, and the growth of the larva is due entirely to a growth in the size of the larval cells Now as these cells grow larger and larger there is formed an increasing disproportion between the volume of the cell contents (which increases as the cube of the radius of the cells) and the surface membrane through which the cell contents are being fed (and which increases only as the square of the radius). Eventually, therefore, a time must come at which the cell contents cannot any longer receive sufficient nourishment through the cell membrane. Death by starvation must be the result—indeed, the more rapidly the larva feeds, the sooner it will starve. This great increase in the size of cells must also have another effect. The delicate chemical reactions occurring within the cells are of such a nature that they are very efficient in minute cells; but it is quite conceivable that as the distances through which diffusions and other molecular movements, taking place within cells, become increasingly larger, a critical volume will be reached at which the delicate balance between the reaction is upset and cellular death is the result. As the cells all grow approximately equally rapidly, a simultaneous death of cells throughout the larva will occur; the leucocytes then fall upon the *débris*, and the result is phagocytic histolysis In insects which do not undergo metamorphosis, on the other hand, growth is produced largely by cell proliferation. The cells do not reach their critical state and extensive cell-death does not occur.

While I am convinced that it is nothing but this great cell growth to which the whole wonderful transformation is to be attributed, yet I am aware that a number of objections may be made against it. If, as it seems, the individual cells have certain critical values beyond which life is no longer possible, how is it that underfed larvae, in which the cells have not reached this critical volume, may nevertheless metamorphose? It is to be noted, however, that in underfeeding (partially starving) the active larvae we are actively applying the very factor which must inevitably appear as the cells hypertrophy, *viz.*, starvation. This objection may, indeed, be turned into a strong support for the view which I have above expressed.

A more serious objection is that in cold weather the larvae may live for months after the cells have attained the critical volume. However, it has been pointed out by Chun that the abundance of life in arctic and antarctic waters is due to the greater length of life of the organisms living there, due to a slackening of the metabolic processes with the lowering of the temperature. Probably the lowered temperature acts similarly on these mature larvae, temporarily repressing those chemical reactions within the cell which result in cellular disorganisation.

The extensive tissue disruption which occurs at metamorphosis is due, then, to the hypertrophied state of the cell, this in turn being the result of a failure of the larval cells to divide. A more complete explanation ought, then, to account also for this absence of cell division with the development of specialization by the larval cells. Now I have pointed out, in the foregoing account of the metamorphosis of *Nasonia*, that the larval nucleus does not seem to be able to increase its chromatic contents. A volumetric increase—sometimes quite considerable—of the nucleus is frequently seen, but no increase in the quantity of chromatin is ever to be detected. There may be an increase in the number of chromatin granules, but these are always formed by a breaking up of the karyosome of the nucleus of the young cell (fig. 102). Now it has been pointed out by Professor Brailsford Robertson (1909) that cholin formed as a by-product during the synthesis of nuclein from lecithin, accumulating mainly at the median plane of the cell, would bring about a diminution of surface tension here, and division would result. In the growing larval cells such nuclein synthesis is apparently absent, and consequently no cell division is to be expected. Specialization may perhaps consist then, in part, simply in the loss of the nuclein synthesizing enzymes.

The investigations of Poyarkoff have shown that in *Galeruca* many of the larval cells transform themselves into imaginal cells by undergoing a process of rejuvenation; portions of the old cells are cast out and the interactions of the remaining substances transform the cell into that of the adult. The cytological interpretation of these results is very difficult. But is it not possible that those cell substances which have (phylogenetically) recently been acquired—substances the acquisition of which has enabled the cells gradually to adapt themselves to the new conditions, as the feeding habits of the evolving larva gradually diverged from those of the adult—may become starved out from the cells as they gradually approach the critical volume? These substances are, in a sense, "foreign" to the cell; while the cell lived under its new environment (the *larval* environment) they thrived; but as the cells gradually weakened with increasing cell volume, would it not be these very substances which would perish first? And is it not possible that the substances which Poyarkoff observed emerging from the rejuvenating cells were nothing but the substances to which the larval cells owe their new properties? These considerations will become clearer when we have examined the phylogeny of the insect metamorphosis. It is sufficient to point out here that even in the "cell rejuvenation" type of metamorphosis the same stimulus—the attainment of a critical cell volume—may bring about the sudden transformation. In these forms divergence of the cells from the imaginal condition has not proceeded so far as to prevent the cells returning to it, but in the more profound metamorphoses the greater specialization of the larval cells has resulted in a far more marked departure from the imaginal type; the cells are unable to recover when they reach the critical volume, and death is the result.

Cell rejuvenation, then, is to be looked upon as a sudden differentiation in a cell in which this has been, for some reason, delayed; it differs from differentiation as more usually seen, in that here the process is gradual. No satisfactory explanation has yet been offered for the extraordinary phenomenon of cell differentiation—the gradual transforming of a cell from a non-differentiated truly embryonic state into one whose structure is correlated with its function But the "abnormal" differentiations to be observed in metamorphosing insects seem to throw considerable light on the process. It is well known that non-differentiated cells may quite successfully perform work which is usually carried out by differentiated cells. For instance, the heart of a chick embryo beats long before cardiac muscle becomes differentiated. I have similarly observed undifferentiated muscle cells of *Nasonia* functioning successfully. Now, it is well known that cell growth and cell differentiation are parallel events in embryonic processes. Tissues consisting of cells with definite hereditary characteristics are laid down; the constituent cells grow and the tissues, or better, their component cells, differentiate. Is it not possible that in the struggle for existence that must ensue as the cells grow in size, all but the non-essential substances—all those substances to which the *generalized* condition of the embryonic cell is due—gradually disappear? Only those substances which are essential persist. The "explanation" is very incomplete, and there are many difficulties in the way of its acceptance. But it seems to me that it contains an element of truth.

It is necessary to consider next the course of evolution of the insect metamorphosis, and to consider the factors which have necessitated this evolution. Lubbock has pointed out that a metamorphosis is a necessity in organisms whose adult and larval mouth parts are structurally unlike. This does not, however, explain the reason for the metamorphosis of the more insignificant structures of the insect's body. Nor does it help us to understand why the insect larva which shows this metamorphosis should ever have been evolved.

The phylogenetic significance of the larva has, I believe, frequently been explained correctly. It is a stage which has been gradually inserted into the direct development, feeding gradually became confined to the earlier part of the life period, further development to the latter. In other words, processes which ran side by side, have gradually become separated. This conception is undoubtedly correct; but no explanation has, so far as I am aware, ever been offered as to why such a complex process should ever have replaced the simpler one, nor have the various types of metamorphosis ever been considered as throwing light on the structural changes through which the insect passes as they developed metamorphoses. It is these questions that I wish to discuss here.

When we consider the insects as a group and seek to account for their extraordinary success in nature, two characters in their structure present themselves to us—the wings, which have enabled them to conquer a new environment; and the hard chitinous body wall, which makes them so secure against attack. For the less specialized insects—cockroaches, silverfishes, grasshoppers, etc.—which live in truly hidden localities (Cryptozoa), these structures, though important, are not constantly essential. A grasshopper may pass much of its life without wings and may even temporarily cast its cuticle. For the females of such insects, moreover, a large egg mass is no fatal burden, and we find that the eggs are well provided with yolk. The presence of this yolk enables the embryo to undergo a large part of its development within the egg.

In the earlier Palaeozoic times none but these generalized insects existed. But as the struggle for existence increased, these insects began to adopt more fully the new environment which had become available to them when wings were evolved; as the pressure of life increased more and more this specialization became more and more marked, till there was produced the marvellous diversity of form that exists to-day.

Now this specialization must have had two marked consequences:—

(a) As the insects began to adopt a more active type of existence such as we see in the Diptera, Lepidoptera, and many Coleoptera, it became increasingly hazardous, or even impossible, to moult during this period of active life. It would be clearly impossible for a butter-fly or a blow-fly to undergo a moult at the present day. Moreover, the cuticle of these specialized insects constitutes a considerable proportion of the body weight. The casting and reforming of this, several times, would be an insurmountable strain on the insect's economy.

(b) With increase in activity it became more and more impossible to carry large masses of yolked eggs. Either the

quantity of yolk within the eggs would have to decrease, or the number of eggs would have to diminish. While the latter may have occurred, there is no doubt that the former process has predominated, till in the chalcid wasps we find eggs in which yolk may be almost absent.

Under the influence of the first factor *(a)*, with increase in specialization it became increasingly necessary that feeding should occur earlier, and ever earlier in the free living period of the insect. Under the influences of the second factor *(b)*, it became necessary that the larva should hatch in a more and more incompletely developed condition. The result of the co-operation of these two processes has been very marked In the less specialized insects as growth became more concentrated in the earlier part of the free living period, the imaginal cells had to adapt themselves temporarily to rapid feeding conditions; only after a considerable time did the delayed differentiation occur. The metamorphosis here is very simple (Odonata), and the cells which have already begun to specialize in a certain direction (that of rapid feeding and growing) can, nevertheless, evidently attain the imaginal condition with comparative ease. The Coleoptera emerge from the egg in a more primitive condition, and while some tissues can still rejuvenate, others are unable to do so; they die and the adult organs are formed from imaginal discs. In the Muscidae this process has gone much further. But in the chalcid wasps the divergence from the imaginal condition is most marked of all. It it customary to regard the Muscids as showing the most marked of metamorphoses, but in this they are far surpassed, it seems to me, by the chalcid wasps. The state of embryonic development in which their larvae hatch has been pushed so far back that the head is still in a bisegmentated condition, appendages are almost entirely absent, malpighian tubes are not yet formed, the mandible may still exhibit the crustacean palp, and the proctodaeal ingrowth has not yet opened into the archenteron. So specialized, moreover, has the larva become to absorbing food rapidly, that it does not apparently even take time, as far as I could observe, to excrete nitrogen. All its food is stored in the form of hypertrophied larval cells within its body, and not till the cells attain their critical volume does transformation occur.

It is scarcely necessary to point out that as the insects gradually developed metamorphoses, the instincts of the parents had to undergo marked modification. As feeding had to become concentrated at the beginning of life, they had to deposit their ova in places where such food was to be obtained.

It is necessary finally to point out the changes through which the tissues must have passed as the metamorphosis gradually evolved. As the simple "rejuvenation" metamorphosis evolved, the cells of the imago had to "learn" to adapt themselves to a period of rapid feeding, perhaps on special foods, in the early part of the life cycle. As the larval condition, which had then become initiated, became more marked greater specialization of cells resulted. For a time these cells were still able to rejuvenate themselves. But as specialization of the imago (and consequently also of the larva, though in a different direction) proceeded, these larval cells must have found it increasingly difficult and finally impossible to transform themselves into the imaginal cells from which they had phylogenetically descended. Death must eventually have resulted in some of the cells. Now as specialization increased still further more and more of these larval cells must have perished; in order that the individual should survive other larval cells would have to undergo a decrease in specialization. And as the present-day specialization of the imago was gradually attained there would thus have had to occur two parallel processes within the larva—an increase of specialization of some cells (the true larval cells) and a decrease in specialization, *i.e.*, a retention of embryonic characters in others. There would in this way be formed *imaginal discs*. That this is the phylogeny of imaginal discs is clearly shown by the fact that these structures are always found in close connection with the structure of the larva to which they correspond; *e.g.*, in *Nasonia* the antennal nerve of the imago arises from a cluster of cells in the brain lying very close to the antennal ganglion of the larva; or, to take a simpler case, the imaginal disc of the adult mandible lies in very close communication with the mandible of the larva. If the mandible of the larva had been evolved quite independently of the imaginal mandible this would not have been the case.

To recapitulate, then, in the struggle for existence which has been going on among insects since Palaeozoic times, the possession of wings and a hard cuticle has enabled the insects to undergo marked specialization. Active flight made the carrying of numerous heavily yolked eggs impossible, and as the laying of numerous eggs has remained essential the quantity of yolk material has gradually diminished, reaching a minimum in the chalcids. On the other hand, the increased loss to the animal economy sustained by the moulting of imaginal cuticles has necessitated that growth in size of the body should become more and more concentrated at earlier parts of the free living period; ultimately moulting has disappeared in the life of the imago. These two processes have resulted in a gradual shifting of the period of growth to the beginning of the free living period; and have at the same time forced the larvae to emerge from the egg in increasingly earlier periods of individual development. The processes of accelerated growth and of premature emergence from the egg have reached their maximum not among Muscids, as is usually supposed, but among the chalcid wasps.

By this gradual concentration of the growth period to the beginning of the post-embryonic life a new organism which may have to fit into a wholly new environment has been produced—the larva. Coenogenetic modifications, almost as interesting as the adaptations of the adult insect, have arisen; but it is in the protected parasitic larvae that we must look for cases in which the processes of premature hatching and rapid feeding, unfettered by a complex environment, have proceeded the farthest; and it is among the chalcid wasps that the most profound recovery from larval specialization—metamorphosis—is to be found.

It is possible now to obtain a clearer conception of the significance of the pupa. When specialization first developed, return to the imaginal condition was doubtless by means of cellular rejuvenation. Increasing specialization of the imago produced, automatically, as I have shown above, increased specialization towards rapid food absorption. When recovery by rejuvenation from this specialization became impossible, continued specialization of some larval cells must have been accompanied by decreased specialization of others; ultimately the latter would have remained as embryonic cells, and imaginal "discs" were the result.

Now in the early stages of evolution of the larval form, the resulting metamorphosis must have been of a very simple type, differing little, indeed, from direct development; a simple rejuvenation of tissues, such as occurs still to a certain extent amongst Coleoptera, must have occurred. Nothing is known of the metamorphosis of the dragon-flies, but a cell rejuvenation metamorphosis among these forms may be predicted with considerable confidence. There is no extensive tissue death, apparently, and it is not possible here to speak of a pupa in the usual sense of the word. But as the specialization became more marked, extensive tissue death, and corresponding tissue regeneration occurring late in larval life, brought about an absolute break in the orderly developmental process, and the actual development of the less generalized characters of the insect did not begin till after the larval tissues had died. This metamorphoeis begins considerably before the last "larval" moult; eventually when the larva does moult there comes to view a wholly different organism—

we can see now the imago, whose development has been so long delayed, and which would have appeared in this state in the egg if growth of the imago could have been possible. This "larval" moult in the different orders takes place when the embryo is in various states of development. In Lepidoptera the appendages are only feebly developed; the hard secretion of the exposed epithelium effectually serves to hide these. In the chalcids appendages are always well developed; indeed, in this group it is possible to say that the period preceding the pupal moult is the *period of growth in size of the external form of the developing imago, the pupal period the period of its differentiation.* This generalization cannot, however, be applied to the internal organs; it serves merely to emphasize the fact that the peculiar organization of the external features of insects have mainly been responsible for the evolution of metamorphosis. It is scarcely necessary to remark, that the view so often held, *viz.*, that metamorphosis commences in the pupal period, is quite erroneous; for some few tissues this is true, but more usually the most profound changes occur under the shelter of the old larval cuticle.

It is interesting, in conclusion, to observe that the insects do not, after all, provide an exception to the generalization of Von Baer, that resemblances between different species become closer as we examine ever earlier stages of their embryonic development. It has more than once been remarked that the pupae of related insects are more alike than their larvae; but when we remember that the larva is a younger product of evolution than the embryo which succeeds it in development, and which is revealed at the pupal moult, then our confidence in the law, the truth of which has lately been so much questioned, must become stronger than ever.

SUMMARY.

A. External Features.

The subject of this investigation is a small chalcid wasp, *Nasonia*, parasitic on muscid pupae, and world-wide in distribution.

The larva, which is composed of fifteen segments (2 head, 3 thoracic, 10 abdominal), feeds for three days and then begins to metamorphose; a day later the contents of the intestine are voided (defaecation period), another day later, after the developing imaginal discs have grown into the form of the imago, the "larva" moults and discloses the pupa. Further development of imaginal organs and disintegration of larval tissues occur during the pupal period On the fourth day of pupal life the integument chitinises and the imago is seen lying within the transparent pupal sheath.

The development of the head from the first two segments is fully described The head appears to be composed of five primitive segments. The mouth appendages develop by the evagination of imaginal discs. The latter are seen in the first larval instar as thickenings of the integument, consisting of minute embryonic cells. These, like the appendages of the legs, wings, and abdomen (in females) become invaginated during larval life as the surrounding larval cells increase in size, and only evaginate again at metamorphosis. These, and all other imaginal tissues, are to be observed in the larvae at all stages of their development The most noteworthy feature in the mouth appendages is the occurrence of a mandibular palp In the antennae, organs of smell, touch, and hearing are described.

The compound "thorax" is described as consisting of three thoracic segments, as well as the first abdominal and dorsal part of the second abdominal. The lower part of the second remains as the petiole. This is contrary to accepted views. Legs and wings are formed as outgrowths from invaginated discs on the ventral side of the thoracic segments.

The ovipositor is formed by the outgrowth of three pairs of imaginal discs on the twelfth, thirteenth, and fourteenth segments; they come into intimate relation and co-operate to form the complex ovipositor.

The penis is formed as a remarkable modification, accompanied by partial invaginations, of the hinder abdominal segments

B. Histological Changes in Integument

The larval cells, having grown greatly in size during the feeding period, disintegrate; in part they dissolve in the blood: in part they are removed by leucocytes. The minute imaginal cells develop at their expense and no break in the integument is ever to be seen. The underlying somatopleure also metamorphoses.

Bristles are formed as partial chitinisations of cells or groups of cells which have grown out into the form of bristles. Pubescences are formed as chitinisations of the frayed exteriors of other cells. Phragmas are formed as cleft-like invaginations of the integument; false phragmas by the downgrowth of the margin of segments.

The eye is represented in the first intsar by an integumental thickening consisting of three layers of cells. From the outer develop the lens, and vitreous cells; from the middle the "retinula" and pigment cells; from the lower the rhabdome cells. The cells arrange themselves in little groups (ommatidia) each consisting of one central rhabdome cell, surrounded by seven sheath ("retinula") cells (of which one later disappears), which are, in turn, surrounded by four pigment cells. At the outer end are formed four vitreous and two lens cells The latter surround the former and their upper ends secrete the lens The rhabdome cell chitinises. An ingrowth from the ectoderm which surrounds the eye forms a membrane beneath the developing eye ("perioptic membrane"). Its cells serve as neurolemmae for the cells of the optic ganglion. The remarkable process of the development of the eye innervation in connection with the perioptic membrane is fully described.

The ocelli are similarly modifications of the integument only, and the nerve reaches them, quite independently, from the brain.

C. Respiratory System.

The larva has a pair of longitudinal tracheal trunks, connected by transverse trunks in front and behind. The longitudinal trunks open to the exterior by four short stigmatic trunks, which increase to nine in the second larval instar. The air is carried to the tissues by extraordinary tracheoles, of a kind not hitherto, apparently, described. Each branching system, of which there are two to five in a segment, is simply a highly branched hollow cell, formed from a greatly modified cell of the tracheal epithelium (giant tracheoloblast). Increase of complexity during larval life is produced by growth of the size of these cells, and by further branching.

The whole tracheal system degenerates at metamorphosis, partly dissolving in the blood, partly removed by leucocytes after degenerating. A simultaneous regeneration from embryonic cells which form imaginal "nests" at the bases of all the stigmatic trunks, prevents any discontinuity in the tracheal system occurring. The embryonic cells grow over the dead larval cells of the main trunks; growing out in places they now form the true branching multicellular tracheal vessels in the head, alitrunk, and abdomen. Some of them are modified into the great thoracic air sacs. The "spiral" intima of the tracheae is formed as a chitinisation of ridges formed on the inside of the cells which compose the tracheal epithelium.

D. The Muscular System.

The larval muscular system begins to degenerate in places before defaecation, *e.g.*, in the thorax, embryonic cells (myoblasts) begin to crawl over certain dorsal longitudinal thoracic muscles which are beginning to lose their striations and ultimately form the wing muscles. They penetrate the muscles, which soon become riddled with these cells and ultimately absorb them, in their place is formed a pair of bands of myoblasts. Some of these myoblasts fuse in five longitudinal columns within each band, and the syncytium remains as the sarcoplasm of the future "wing muscles" Other myoblasts send off processes into these columns and form the sarcostyles of Schafer, which are therefore fibres, not fibrils, as usually supposed. Each band then breaks up into its five constituents, and the great "wing" muscles of the thorax are formed. The "muscle insertions" are always integumental cells.

Other muscles of the larva, which may show all kinds of disintegration processes, may become absorbed by leucocytes; others, again, dissolve slowly in the blood stream, usually throwing out large rounded globules as they do so. A specially remarkable case of disintegration is seen when the whole of the minute sarcous elements are cast out as a fine shower of "bacillus-like" rods into the blood stream where they dissolve (fig. 104).

In all cases the adult muscles are regenerated from embryonic cells (myoblasts), like leucocytes in appearance, which have lain dormant during larval life. They unite one after the other to form syncytial columns, one or more cells in thickness. If more than one cell in thickness the columns may (head, leg, and ovipositor muscles) or may not (pharyngeal dilators) become pulled apart to form a number of narrower columns. Each of these columns undergoes fibrillation and striation by a method quite different from that described in the "wing" muscles. In structure the muscles always present striations in the form of double spirals. Certain unicellular intestinal muscles may be markedly branched, each branch consisting of only a few fibrials. Striation is here truly transverse.

E. The Intestine.

The larval intestine consists of fore-, mid-, and hindguts. The latter does not open into the midgut till towards the end of larval life. This marks the defaecation period.

The imaginal tissues are (1) a ring around the posterior end of the oesophagus, (2) scattered cells at the bases of the larval cells of the midgut, (3) cells surrounding the anterior parts of the rectum. Salivary glands are well developed; into the midgut open three hepatic caeca; *malpighian tubes are absent in the larva.*

On the fourth day of larval life the foregut and rectum degenerate and are rapidly regenerated by cells growing from the imaginal rings. The oesophagus is also partly regenerated from the head integument, which creeps in through the mouth. The cells of the midgut disintegrate by a remarkable process of globular degeneration and fall into the lumen of the gut, the epithelium is rapidly regenerated by the "imaginal" cells of the midgut. The hepatic caeca become bodily drawn in through the walls of the degenerating larval midgut. This is produced by pressure from the regenerating epithelium. The function of this epithelium is to absorb the disintegrated cells. The anterior portion of the epithelium then itself breaks up into a fine *débris* and is absorbed by leucocytes, the posterior part remains as the stomach. Meanwhile the imaginal ring of the oesophagus has formed a great cone of cells, which temporarily has closed the midgut in front. The cells of this cone now grow back through the thorax and fuse with the stomach; they differentiate to form gizzard and crop. The malpighian tubes grow out from the anterior part of the hindgut in the defaecating larva The hindgut bends upon itself on account of rapid cell proliferation; the anterior part is the small intestine, the hinder the short rounded rectum. Within its walls is formed a pair of rectal glands, by thickening of the epithelium.

The salivary glands, after disintegrating, are phagocytised. A single salivary gland is formed by ingrowth of cells from the regenerated oesophageal epithelium. Only one salivary gland occurs in the imago.

F. The Ductless Glands.

(1) *The Oenocytes.*—The larval oenocytes grow in size but do not proliferate: at metamorphosis they simply disintegrate. Leucocytes may at times aid in their removal. The imaginal oenocytes are formed from small clusters of cells which grew inwards from the ectoderm in the early larva. They separate and scatter themselves between the fat cells.

(2) *The Lateral Intestinal Glands* are a pair of long chains of glandular cells lying just beneath their lateral hepatic caeca. They disintegrate during metamorphosis.

(3) *The Dorsal Abdominal Glands.*—The imaginal anlage of these is a band of cells lying in the young larva dorsally on the end of the midgut. They grow and proliferate late in larval life and resemble empty fat cells. During late pupal life they assume a glandular appearance. They persist throughout imaginal life and are *not* pericardial cells or young fat cells.

G. The Fat-body.

The cells of the fat-body do not proliferate during larval life They grow in size and store fat and other (protein ?) foodstuffs in their cytoplasmic meshwork Before defaecation excretory crystals may accumulate within them, though these soon disappear when the malpighian tubes form, and are cast into the stomach, where they accumulate during the pupal period

The storage products gradually disappear during pupation, as the imaginal tissues grow at their expense. Frequently the remnants of the fat cells, deprived of their storage substances, are phagocytised. Others persist throughout pupal and imaginal life. There is no regeneration of fat-body. Some of the fat cells are seen to have a capacity for limited phagocytosis.

H. The Gonads.

These occur in the youngest larvae as a pair of club-shaped masses attached to the ventral body wall. They begin to grow at metamorphosis and develop directly into the adult organs The male organs often show ripe sperms already in the third day of pupal life. The ovaries continue to develop during imaginal life

I. The Nervous System.

In the larva there is a brain above the oesophagus connected to a ventral nerve cord consisting of twelve ganglia, the last of which consists of three fused ganglia. A single stomotogastric ganglion is present. The nerve cord and brain are composed of larval cells and imaginal neuroblasts. During metamorphosis the former degenerate, and the latter proliferate. In the nerve cord the dead cells which form masses of necrotic tissue there, are quickly absorbed: into the degenerate strands of fibres that run along the cord, the new nerve cells send their growing nerve fibres, and no discontinuity is to be observed. In the peripheral nerves, the fibres break into globules which, passing out, dissolve in the blood or are phagocytised. All these changes take place within the splanchnopleural covering of the nerve cord, which itself metamorphoses by imaginal cells replacing dead larval cells, and no discontinuity occurs in it. It follows, therefore, that no discontinuity is to be observed in the nerve cord and peripheral nerves as a whole, although the most profound changes are taking place within it. These changes are completed before pupation; a migration of nerve cells (*i.e.*, of ganglia) then commences and the concentrated nervous system of the imago is formed.

Similar changes occur in the brain: but within it the dead larval elements lie for more than a day as masses of degenerate cells, before these are absorbed by the imaginal cells. The first ventral ganglion is merged into the brain, and it is much more complex than in the larva.

Leucocytes do not take part in the metamorphosis.

J. The Vascular System.

The blood acts as the medium into which the nutrient degeneration products of the larva are poured and from which the imaginal cells again take them. Often the leucocytes, which proliferate considerably during metamorphosis, may aid in the removal of the dead larval elements by phagocytising them.

The larval heart consists of a long tube, provided with ostia, and lying within a delicate pericardium. Imaginal cells lie within the heart walls and regenerate it at the time of defaecation The larval pericardium undergoes total degeneration. In its place is formed a band of cells right along the ventral side of the heart; the cells originate from an imaginal disc lying ventral to the heart, just above the end of the hindgut. This band of cells then grows upwards and completely surrounds the heart, forming a two-layered organ, which becomes muscular behind (heart), remaining non-contractile in front (aorta). There is therefore no true pericardium in the imago.

K. The Insect Metamorphosis.

Insect metamorphosis is brought about by an extensive tissue death, due to the hypertrophy of the larval cells. Death of the cells is due to an automatic starvation, due to the fact that the cell contents, which increase as the cube of the radius of the growing cells cannot be nourished indefinitely through the cell membrane, whose area increases only as the square of the radius. The hypertrophy must also cause disorganization, as the distances through which diffusions, etc., within the cells have to take place, become appreciable.

Metamorphosis has been evolved as an outcome of specialization by the imago. A hard thick cuticle has necessitated concentration of the growth period to the beginning of the free living period, and the active life led by the adults has made the carrying of large quantities of heavily yolked eggs impossible. With continued decrease in the quantity of yolk, the larva has had to emerge at ever earlier stages of its development. At metamorphosis we see the continuation of the interrupted development, and a recovery of the organism from larval specialization.

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a.: Antenna ab.1-ab.10: Abdominal segments. a.d.: Imaginal disc of antenna. a.g.: Accessory glands. a.g.i.: Imaginal antennal ganglion. a.g.l.. Larval antennal ganglion. a.l.: Antennal lobe. an.: Anus. a.n.: Antennal nerve. ant.: Second (true) antenna. a.p.: Adhesive pad. app.ab.10: Appendage of tenth abdominal segment. a.s.: Antennal nerve strand b.m.: Basement membrane. br.: Brain. c.: 'Drum-shaped" chamber c.o.c.: Circumoesophageal connective. cr.: Crop. d.a.g.: Dorsal abdominal gland. d.g.: Degeneration globules. e.: Eye. e.op.: Epiopticon. ex.m.: Extensor muscle. f.: Sarcostyle. f.b.: Fat-body. f.c.: Follicle cells. f.g.: Fore gut. fl.m.: Flexor muscle. g.1-g.12: Ganglia of ventral nerve cord. gl.: Lubricating gland. gz.: Gizzard. h.: Heart. h.c.: Hepatic caecum. i.c.: Intestinal cell. i.d.: Imaginal disc of integument. i.i.c.: Imaginal integumentary cells im.c.: Imaginal cell. int.c.: Integumentary (larval) cell. i.o.c.: Imaginal oesophageal cell. i.oen.: Imaginal oenocytes. i.t.c.: Imaginal tracheal cell. i.t.r: Imaginal trachea. j.: Jaw of larva. k.m.: Krause's membrane. l.: Leucocyte. l.1-l.3: Legs. lab: Labium. lbr.: Labrum. l.c.: Lens cells. l.d.: Imaginal disc of leg. l.i.g.: Lateral intestinal gland. l.m.: Longitudinal muscle. l.o.c.: Larval oesophageal cell. l.p.: Labial palp. ls.: Lens. l.s.: Larval cuticular sheath. l.t.c.: Larval tracheal cell. l.v.c.: Larval cell. m.: muscle. malp.t.: Malpighian tubule. md.: Mandible of imago. m.d.: Imaginal disc of mandible. md.p.: Mandibular palp. m.g.: Mid gut. m.i.: Muscle insertion ms.tx.: Mesothorax. mth.: Mouth. mt.tx.: Metathorax. mx.: Maxilla. mx.p.: Maxillary palp. myb.: Myoblasts. n.: Nucleus. n.c.: Nerve cell. nc.: Nutritive cell. ng.c.: Neuroglia cell. nml.: Neurolemmal cell. n.o.: Nerve to oral appendages. nrb.: Neuroblast. n.s.: Nerve strand. n.t.: Dead larval tissue. n.v.: Nerve. o.: Ovum. oc.: Ocellus. od.: Oviduct. oen.: Oenocyte. oes.: Oesophagus. o.g.: Optic ganglion. o.g.2: Middle optic ganglion. o.g.3: Inner optic ganglion. o.gl.: Ocellar ganglion. om.: Ommatidium. o.m.: Oblique muscle. o.n.s.: Ocellar nerve strand. o.p.: Opticon. op.n.: Optic nerve. ost.: Ostia. ov.: Ovary. ovip.: Ovipositor. ovip.1-ovip.3: Imaginal discs of ovipositor, or the structures into which they have developed. p.b.: Polar body. p.c.: Pigment cell. p.d.m.: Pharyngeal dilator muscle. pcd.: Pericardium. ph.: Pharynx. phr.: Phragma. p.m.: Perioptic membrane. p.m.c.: One of the remarkable branching cells of the perioptic membrane. p.op.: Periopticon. pt.: Petiole. pr.tx.: Prothorax. r.d.: Imaginal disc of rectum. rect.: Rectum. rect.g.: Rectal gland. rh.: Rhabdome (or rhabdome cell). rp.c.: Replacing cell of midgut epithelium, *i.e.*, the anlage of the temporary pupal midgut. s.: Syncytial columns of wing muscles. sal.d.: Salivary duct. sal.g.: Salivary gland. s.a.o.: Sensory appendage of ovipositor. s.c.: Sheath cell ("retinula" cell). s.i.: Small intestine. sp.: Splanchnopleure. sp.1-sp.10: Lateral spiracles. spl.: Mesodermal somatopleure. sp.n.: Nucleus of a splanchnopleure cell. s.r.: Sensory rod. st.: Stomach. stg.: Stomatogastric ganglion. t.: Tendon. t.: Testis. t.o.: Ovarian tubules. trb.: Developing tracheoloblast. trl.: Tracheole. t.t.l.: Longitudinal tracheal trunk. t.t.t.: Transverse tracheal trunk. v.: Vagina. v.c.: Vitreous cell. v.d.: Vas deferens. v.n.c.: Ventral nerve cord. v.s.: Vesicula seminalis. vsc.: Vesicle. w.1-w.2: Wings. w.d.: Imaginal disc of wing. w i.: Wing insertion. w m : "Wing" muscles. w.m.b.: "Wing" muscle band. x.: Various structures referred to in text.

DESCRIPTION OF PLATES.

PLATE XV.

Fig. 1. Larva of *Nasonia* towards end of first instar, in ventral view The muscles are shown on one side; on the other are seen the respiratory vessels. The nerve cord is also visible

Fig. 2. Larva at end of feeding period (×55), showing the fifteen imaginal discs of the integument (heavily shaded), one (pair) in each segment The respiratory system is also seen; the alimentary canal is shown in outline.

Fig. 3. Anterior end of larva at time of defaecation (×150). Metamorphosis has commenced, and the various appendages are clearly seen through the transparent larval sheath. Note the fat-body showing up through the integument; note also the *mandibular palp*.

Fig. 4. Abdomen of imago, in ventral view. The numbers refer to the abdominal segments.

Fig. 5. Integumental imaginal disc of larva shown in fig. 2 (×180), showing the invaginated leg anlage.

Fig. 6. Anlage of leg, from the same specimen, viewed in optical section (×300). Note the mesoderm extending into the hollow appendage.

PLATE XVI.

Fig. 7. Fresh pupa (×50), showing migration of first two abdominal segments.

Fig. 8. The same, four days later (× 50). Note the extensive shrinking that has occurred. Note also final position of migrated abdominal segments.

Fig. 9. View of propodeum and adjacent segments of pupa two days old (×70). Note the migrated abdominal segments; also the complex wing insertions.

Fig. 10. Transverse section through first thoracic segment of larva in first instar (×1000). The complete section has not been drawn. Notice the imaginal elements in the integument, nerve cord, and intestine.

Fig. 11. Antennae of female wasp, imago (×120). The bristles are not shown. Note the auditory organs.

Fig. 12. Head of metamorphosing larva, about 17 hours before pupation, *i.e.*, seven hours later than fig. 3 (×150).

PLATE XVII.

Fig. 13. Head of mature larva at cessation of feeding, viewed ventrally, and slightly from one side, showing all the imaginal discs of the mouth appendages (×159). Note the double nature of the labrum; also the true antenna (ant.), which later disappears. Mandibular palps are not visible with certainty.

Fig. 14. Mouth appendages of pupa aged two days (×150). Note shrinking within the pupal sheath.

Fig. 15. Longitudinal section of part of the antenna of thirty-six hour pupa (×450).

Fig. 16. Leg of pupa two days old (×90) The leg muscles are clearly seen.

Fig. 17. Trochanter of leg of imago (×500) to show the nature of the muscle insertions.

Fig. 18. Insertion of tendons of femoral muscles on tibia (×500).

Fig. 19. Tactile bristles on first tarsal segment of first leg, imago (×1500). Note the curious modification of the somatopleural mesoderm cells to act as neurolemmae for the nerve fibres.

Fig. 20. Developing ovipositor from larva seven hours after defaecation (×150).

Fig. 21. The same, several hours after pupation (×180).

Fig. 22. Ovipositor (extruded) of imago. Note the great musculature.

Fig. 23. Section through a part of the propodeum (thirty-six hour pupa) showing the powerful chitin layer (×500).

Fig. 24. Developing pubescence on labium, fifty-six hour pupa (×1500). Chitinisation has just commenced Note cell nuclei.

Fig. 25. Vertical longitudinal section through posterior end of male, to show the migration of segments to form the penis. Note cell proliferation in ninth segment (×150). Fresh pupa.

Fig. 26. Ventral view of extremity of male—two-day pupa (×150).

PLATE XVIII.

Fig. 27. Longitudinal section of posterior end of male—fifty-six hour pupa (×180). The cuticular sheath represents the position of the segments before invagination occurred.

Fig. 28. Integument undergoing metamorphosis, ventral abdominal region of larva eight hours after defaecation. Note the greatly hypertrophied larval cells with large nucleoli, all degenerating. Only a few leucocytes are present. Note the small embryonic cells growing over them (×1200).

Fig. 29. Surface view of a proliferating imaginal disc. The larval cells are degenerating. Some of the embryonic imaginal cells are undergoing amoeboid movement (x), From the larva, shortly after defaecation (×1000).

Fig. 30. Section through integument of larva eight hours before pupation (×1200). Note the empty cell membranes (z) and granular degeneration globules, free, or still within cells.

Fig. 31. Integument from posterior extremity of eight-hour pupa, showing accumulation of degeneration globules amongst the cells of the renovated integument. A leucocyte and a degenerate larval cell are also seen (×1200).

Fig. 32. Section through mid-dorsal abdominal integument. A disintegrated integumental cell is seen, apparently preventing the closing in of the imaginal cells. The heart is also seen (×1200). From the larva twelve hours after defaecation.

Fig. 33. Integument of head showing development of scale-like "bosses." Note that a protoplasmic "mould" precedes the secretion of the similarly shaped cuticle (×1500) fifty-two hour pupa.

Fig. 34. Developing spine of leg (×1200)—fifty-two hour pupa.

Fig. 35. Developing abdominal bristles (×1200)—fifty-two hour pupa. Note the formation of a "mould" by the integumental cells, previous to cuticle secretion.

Fig. 36. Longitudinal section of antenna (×450). Defaecating larva. Note invagination of "padding" tissues, for example at x.

Fig. 37. Portion of wing of four-day pupa, showing hairs, and the characteristic folding. Degenerate nuclei also seen (×750).

Fig. 38. Hooks of hind wing of imago, showing scattered wing nuclei; hook "roots"—remnants of embryonic cells—are clearly seen.

PLATE XIX.

Fig. 39. Stigmal view of fore wing, imago (×1200), showing the four problematic sense organs (speed indicators ?).

Fig. 40. One of the sense organs of stigmal vein (×2000),

Fig. 41. Section through a joint membrane—modified cuticle (×500).

Fig. 42. Section through free part of ovipositor of four-day pupa (×600).

Fig. 43. Vertical section through a cephalic phragma (thirty-six hour pupa); developing antennal muscles are seen; also a fat-body and degenerating leucocytes (×1200).

Fig. 44. Fore wing of twenty-four hour pupa. Note shrinking within the old cuticle. Note also the two clear channels each containing tracheoles (×80)

Fig. 45. Vertical section through the wing of four-hour pupa, to show the band of mesodermal cells (k) growing downwards, to enter the anterior clear channel (×500).

Fig. 46. Optical section of tip of tarsus of imago (×750).

Fig. 47. Section through head of larva in first instar, right half only shown (×500).

Fig. 48. Section through mandibles of larva twelve hours after defaecation.

Fig. 49. Section along part of first segment of antenna, to show nerve endings or tactile bristles (×1200)—four and a half day pupa.

Fig. 50. A tactile bristle from ovipositor appendage, showing the receptor cell (×1500).

Fig. 51. Sense cells below cuticle of antennal joint of imago (×1500).

Fig. 52. Longitudinal section through the "olfactory segment" of antenna, showing the suspended sense organs (×1200).

Fig. 53. Surface view of one of the more anterior antennal segments, showing four auditory organs (×1200).

Fig. 54. Cells of the optic imaginal disc of larva in first instar (×2000).

PLATE XX.

Fig. 55. Vertical section through imaginal disc of eye in larva of first instar (×1000).

Fig. 56. Ommatidia from developing eye at time of defaecation (×1500).

Fig. 57. The same, eight hours later (×1500).

Fig. 58, a, b, c. The same, eight hours later than fig. 57 (×1500). d. The same, in tranverse section. Note the seven sheath cells (×1500).

Fig. 59. Ommatidium from pupa, four hours old (×1500).

Fig. 60. Ommatidium of four-hour pupa in transverse section. Note only six sheath cells.

Fig. 61. Ommatidium of pupa twenty-four hours old (×1500).

Fig. 62. The same, thirty-six hour pupa (×1500).

Fig. 62a. The same, outer end (×1500).

Fig. 63. Outer part of ommatidium of fifty-two hour pupa showing pigmentation of sheath cells (×1500).

Fig. 64. Ommatidium from eye of four and a half day pupa (×1500).

Fig. 64A. The same, outer end (×1500).

Fig. 64B. Pigment cell from the same (×1500).

Fig. 64C. Section through vitreous cells of same (×1500).

Fig. 64D. Section through terminations of several ommatidia at same stage (×1500).

Fig. 65. Fresh pupa, anterior half, to show tracheal vessels (×40).

Fig. 66. Section of ocellus in two-celled stage, from the larva in first instar (×1000).

Fig. 67. Section through developing ocellus from the fresh pupa (×1000).

Fig. 68. The same, twelve hours later (×1000).

Fig. 69. The same, from thirty-six hour pupa (×1000).

PLATE XXI.

Fig. 70. The same, three-day pupa (×1000).

Fig. 71. Vertical section through median ocellus of imago (×2000).

Fig. 72. A single sensory cell from the same (×2300).

Fig. 73. Pigment cell from fifty-two hour pupa.

Fig. 74. Vertical section through the eye and perioptic membrane, from larva about to pupate (×1200). Several cells of the perioptic membrane are shown. The three types of processes are clearly seen, especially the fibrous processes, which penetrate into the brain. Into these the nerve cells are seen migrating, and one, on the extreme left, has communicated with an ommatidium.

Fig. 75. The same, four hours later, showing nerve cells adhering to the "neurolemmal" cells of the perioptic membrane (×2000).

Fig. 76. A simple respiratory cell from the abdomen of larva eight hours before pupation. An oenocyte is also seen, presenting vacuoles, evidently a sign of degeneration (×500).

Fig. 77. Vertical section through right side of head of larva eight hours after defaecation (×230).

PLATE XXII.

Fig. 78. Section through left side of head of defaecating larva (×230).

Fig. 79. Vertical section through developing eye of thirty-six hour pupa (×400).

Fig. 80. Vertical section through right side of head of four and a half day pupa (×230).

Fig. 81. Central (nuclear) region of giant respiratory cell, from larva sixteen hours after defaecation (×1000).

Fig. 82. Tracheoloblast growing out from regenerating tracheal trunk—defaecating larva (×1000).

Fig. 83. Epithelium of longitudinal tracheal vessel undergoing histolysis (×1000). Leucocytes are attacking the disintegrating cells.

Fig. 84. Metamorphosing anterior transverse tracheal trunk, eight hours after defaecation (×500). Note the tracheoblasts advancing from the sides, beneath the degenerate epithelium, which has not yet begun to disappear.

Fig. 85. Part of the same vessel, eight hours later. A remnant of the larval epithelium is still seen. Note the larval spiral intima within the developing imaginal intima Note also the "ridging" of the epithelial cells (×500)

Fig. 86 Metamorphosing abdominal longitudinal tracheal trunk, from the defaecating larva (×1000). Note the imaginal cells advancing upon the degenerate larval cells, which are partly disintegrating, partly still intact. Leucocytes are present, and three are attacking a tracheole. A large imaginal tracheole is beginning to grow out from the regenerated epithelium.

Fig. 87 Central nuclear region of the great tracheal cells undergoing phagocytic histolysis—fresh pupa (×1000) (*cf.* fig. 81).

Fig. 88. From the large regenerated tracheal vessel (i.tr.) a multicellular tracheal vessel is extending *downwards* into the wing. Beside it a dead larval tracheole (trl.) is being overwhelmed by leucocytes. The figure also shows disintegrating salivary gland tissue, being attacked by leucocytes. Some of the gland tissue has been ruptured by the growing tracheal vessel. (Figure drawn inverted; ×800.) From four-hour pupa.

Fig. 89. Cell proliferation of prothoracic stigmatic trunk (×525). Defaecating larva.

PLATE XXIII.

Fig. 90. Larval tracheoles undergoing phagocytosis (×1000) —four-hour pupa.

Fig. 91. From the regenerated neck tracheal vessel (i.tr.) a very large tracheal trunk has grown downwards and terminated near the mouth. A larval tracheole (trl.) is degenerating, without intervention by phagocytes. From the base of the head a column of myoblasts—developing into the head musculature—has grown up supporting itself upon the dead tracheole. The break of the column is due to its bending out of the plane of section. The figure may be regarded as continuous with fig. 88 on its left (four-hour pupa; ×500).

Fig. 92. Longitudinal section of integument of defaecating larva in region of an abdominal stigmatic trunk, which will not be reformed in the pupa. Notice the hypertrophied larval cells and the proliferating embryonic cells, especially at base of trunk. A fat-body and a group of imaginal oenocytes are also seen (×800).

Fig. 93. Stigmatic trunk of larva in first instar showing imaginal "nest" (i.t.c.).

Fig. 94. Developing dorso-lateral air sac—fresh pupa (×1000).

Fig. 95. Portion of wall of a mature air sac (four and a half day pupa). Notice that a tracheole has grown out from it. Four nuclei, and "spirals" are also seen (×1000).

Fig. 96. A cell of the fat-body from thorax, four and a half day pupa. Note the disappearance of storage products (×800).

Fig. 97. The same, a little later, being attacked by three leucocytes (×1000).

Fig. 98. A fat cell, drawn out and compressed between the great thoracic muscles; note diminution in quantity of storage material (×1000).

Fig. 99. Portion of body musculature of larva in first instar; viewed in the living larva through the transparent integument.

Fig. 100. A single longitudinal muscle (muscle fibre) from the same, composed of four distinct cells. The insertion of the muscle on an integumentary cell is also seen (×1000)

Fig. 101. Piece of a muscle from adult larva, showing double spiral striations (×900).

Fig. 102. Muscle nuclei: (a) from adult larva; (b) from larva in first instar. Note only a slight increase in nuclear size. The older nucleus shows three small nucleoli; there has apparently been no increase in the quantity of chromatin (×1500).

Fig. 103. A tracheole from developing forewing of larva eight hours after defaecation.

PLATE XXIV.

Fig. 104. Part of degenerating oblique abdominal muscle (fibre) showing a disorganization of the sarcomeres—defaecating larva (×1200).

Fig 105. A degenerated ventral longitudinal abdominal muscle (fibre) being attacked by leucocytes. Note the degenerate nuclei, fresh pupa (×1200).

Fig. 106. Dorsal longitudinal muscle, into which myoblasts have penetrated, fresh pupa (×1000).

Fig. 107. The same (×1200). Amoeboid myoblasts have entered the extruded sarcoplasm.

Figs. 108, 109. The same (×1000) in various degrees of metamorphosis.

Fig. 110. Degenerating circular (oblique) muscle from propodeum. Myoblasts are extending over the degenerate fragments of larval muscle. A few leucocytes and extruded degeneration globules are also seen (×1200).

Fig. 111. A regenerated abdominal muscle, thirty-six hour pupa. Cell limits are still indistinctly visible. Fibrillation has not yet commenced (×1200).

Fig. 112. Longitudinal section through proliferating myoblasts of mesothorax, to form the great "wing" muscles (×900) —defaecating larva.

Fig. 113. The same, in prothorax; myoblasts extending over a larval muscle, in which striations are still visible—defaecating larva (×1200).

Fig. 114 The great column of myoblasts in head, being drawn apart into its constituent muscles (×800)—thirty-six hour pupa. The column, at a much earlier stage, is shown in fig. 91.

Fig. 115. A small portion of the same, to show traces of the separate myoblasts (×1500).

Fig. 116. The same, fully developed--four and half day pupa (×1200).

PLATE XXV.

Fig. 117. Longitudinal section through the head of defaecating larva near mid-line (×500). The oesophagus, salivary duct, pharyngeal dilator muscles and integument are undergoing metamorphosis.

Figs. 118, 119. A pharyngeal dilator muscle degenerating without the intervention of leucocytes—defaecating larva (×1200).

Figs. 120, 121. Myoblasts overwhelming pharyngeal dilator muscles. In fig. 120 the striations are still present.

Fig. 122. Regenerated pharyngeal dilator muscle—fresh pupa (1200).

Fig. 123. The same; fibrils present; striations are already plainly visible below, still developing above.

Fig. 124. The same—four and a half day pupa. This muscle shows several "roots," which is unusual The structure of the pharynx is also shown. Note the thick muscle layer (×1200).

Fig. 125. A branched contractile cell from the crop—four and a half day pupa (×1200).

Fig. 126. Longitudinal section through the insertions of adjacent body muscles (×800)—adult larva.

Fig. 127. Longitudinal section of insertion of a larval muscle on the integument (slightly diagrammatic). The spindle-shaped sarcomeres are clearly seen. Also Krause's "membrane" (k.m.) (×1500).

Fig. 128. Developing "wing" muscles Transverse section through proliferating myoblasts in prothorax, prior to stage shown in fig. 130. The column of myoblasts on left of figure is growing independently of the larval muscles. The others, which are more scattered, are enveloping and drawing together the three degenerate larval muscles—eight hours after defaecation (×800).

Fig. 129. The same, slightly more anteriorly, showing myoblasts penetrating into the larval muscle, which is shown in transverse section. A leucocyte is also absorbing part of the muscle (×1200).

Fig. 130. One of the two bands of myoblasts in transverse section; all larval elements have disappeared—eighteen hours after defaecation (×800).

Fig. 131. The same, four hours later; the fine syncytial columns are beginning to form (×1000).

Fig. 132. Diagrammatic section through the thorax, to show the relative size and positions of the two muscle bands (×40)—fresh pupa.

Fig. 133. The same, four and a half days later. Note disappearance of fat-body, decrease in diameter of oesophagus, and increase in size of muscles (×40).

Fig. 134. A muscle band in transverse section. More cells have become merged into the syncytium—four-hour pupa (×500).

Plate XXVI.

Fig. 135. Longitudinal vertical section through the anterior end of the developing "wing" muscles—fresh pupa (×500). Note three of the syncytial columns (s) applied to the integument, whose cells are now dividing to form the insertion cells.

Fig. 136. The same, eight hours later (×500). Note the long insertion threads, consisting of two cells generally. At x an integumental cell is elongating.

Fig. 137. The same, sixteen-hour pupa. The threads have now split and are unicellular, and shortening has commenced (×450).

Fig. 137a. The same, thirty-six hour pupa. The insertion cells have completely retracted (×500).

Fig. 138. The same, four and a half day pupa (mature). The insertion cells have now broken up into fibrils, on each of which a sarcostyle is inserted (×1200).

Fig. 139. This shows five myoblasts each giving off the fibrils which, growing into the syncytial mass, become the sarcostyles.

The drawing is from a section which just cut the free edge of the developing muscles, and the syncytial column has not been represented—sixteen-hour pupa (×1500).

Fig. 140. Intestine of adult larva (×60).

Fig. 141. Extremity of lateral hepatic caecum of adult larva (×200).

Fig. 142. One of the two salivary glands of adult larva (×200).

Fig. 143. Longitudinal section through the rectum of larva in first instar (×500). Note the blindly ending midgut and rectum.

Fig. 144. Transverse section through midgut defaecating larva. Two cells undergoing globular degeneration are seen. A single replacing cell is visible (×800).

Fig. 145. The same, four hours later (×1200). Notice the shrinking in size of the larval cells and the proliferation of the replacing cells.

Fig. 146. The same, eight hours after defaecation; one side of the intestine is shown in section. Note the hepatic caecum, and the retention of larval cells in the intestinal epithelium adjacent to it (×500).

Fig. 147. The same, sixteen hours after defaecation. The whole intestine is shown in section. Note the drawing in of the hepatic caeca through the walls of the intestine as the last remains of the dead cells are forced inwards (×500).

Fig. 148. The same. The hepatic caecum is being sucked in (×500).

Fig. 149. Section through salivary gland, in larva about to pupate (×500). Note the globular degeneration.

Fig. 150. Portion of malpighian tube of imago (×1200).

Fig. 151. The same, developing in defaecating larva (×1200).

Fig. 152. Longitudinal section through junction of oesophagus and midgut, showing the proliferating cells of the imaginal disc of foregut—defaecating larva (×500).

Fig. 153. The same, four hours after pupation. Note leucocytes attacking the disintegrating temporary midgut (×500).

PLATE XXVII.

Fig. 154. Median longitudinal section through three-hour pupa, to show position of the various structures (×80). Note the regenerated temporary midgut (m.g.) ending blindly at either end, and filled with the *débris* resulting from the degeneration of the larval midgut. The oesophageal cone (o. cn.) is also seen.

Fig. 155. Longitudinal section along the junction of the stomach and developing crop, gizzard, etc., after the front half of the midgut has disintegrated—eight-hour pupa (×500).

Fig. 156. The same, thirty-six hour pupa. Note differentiation of crop, gizzard, and "drum-shaped chamber" (×500).

Fig. 157. The same, a little later, showing the opening of the foregut at last into the stomach (×1000).

Fig. 158. Small portion of adult oesophagus; note the delicate spindle-shaped cells (×1000).

Fig. 159. A small portion of wall of crop, to show the folded "papery" cells (×1000).

Fig. 160. Section through gizzard of adult (×1000).

Fig. 161. Section along the rectum of fresh pupa, showing developing rectal glands (×800).

Fig. 162. Section through anterior end of rectum in larva twelve hours before defaecation. Note the malpighian tubes commencing to grow out (×500).

Fig. 163. Section through one of the rectal glands—twenty-one hour pupa (×500)

Fig. 164. Section along a rectal gland of imago (×800).

Fig. 165. The same; only the thread-like basal cells represented (×1500).

Fig. 166. A nucleus from the rectal gland.

Fig. 167. Epithelium of small intestine of imago (×1500).

Fig. 168. Epithelium of rectum of imago (×1500).

Fig. 169. Section along a lateral interstinal gland of defaecating larva (×800).

Fig. 170. Transverse section of the same, sixteen hours later, undergoing degeneration (×1000).

Fig. 171. Portion of dorsal-abdominal gland from four and a half day pupa. In this condition it persists throughout life.

PLATE XXVIII.

Fig. 172. The same, in fresh pupa (×800).

Fig. 173. Transverse section through the anlage of the same on the postero-dorsal region of the midgut, first larval instar (×1200).

Fig. 174. Fat cell from thirty-six hour pupa (×800). The heavy dots represent the basic storage products; the lighter ones the eosinophilous substances. Eight fat globules are seen.

Fig. 175. Several oenocytes which have been invaginated from the ectoderm-larva in first instar (×1200).

Figs. 176, 177. Disintegrating oenocytes fresh pupa (×1000).

Fig. 178. Three leucocytes attacking a degenerate oenocyte (×1000)—fresh pupa.

Fig. 179. Oenocyte in the imago (×1200).

Fig. 180. Female reproductive organs—imago.

Fig. 181. Termination of left accessory gland in longitudinal section (*cf.* fig. 180) (×500).

Fig. 182. Portion of right accessory gland (×800).

Fig. 183. One cell from same, to show glandular structure (×1500).

Fig. 184. The "lubricating gland" of ovipositor in section (×800).

Fig. 185. Section through left half of body of larva in first instar in region of testis (×500).

Fig. 186. Structure of testis in first larval instar. Numerous spermatogonia and one supporting cell are seen (×1500).

Fig. 187. Structure of ovary—defaecating larva. Note some incompletely divided oogonia (×1200).

Fig. 188. Scent gland of female, opening on body surface (×500).

Fig. 189. Section along an ovarian tubule in four and a half day pupa. Note the formation of clusters of nutritive and follicle cells. No ovum is as yet recognizable. Most of the distal cells are in mitosis (×1000).

Fig. 190. Small part of ovarian tubule of imago, showing nutritive cells, follicle cells, ovum, and a polar body (×500).

Fig. 191. The same (×350). Note alternate ova and nutritive cells.

Fig. 192. Section through end of ovary (fresh pupa). Note fourfold connective tissue ingrowth (×350).

Fig. 193. Two larval leucocytes (×1500).

Fig. 194. Leucocyte from eight-hour pupa, showing great vacuoles (×1500).

Fig. 195. Leucocyte in eight-hour pupa, which has engulfed numerous minute pieces of larval tissue (×1500).

Fig. 196. Dividing leucocyte, sixteen hours before pupation (×1500).

Fig. 197. A leucocyte which has engulfed several large strips of larval muscle (×2000).

Fig. 198. Leucocyte that has engulfed larval tissue (×2000)

Fig. 199. As in fig. 197 (×2000).

Fig. 200. "Normal" leucocyte, adult larva (×2200).

Figs. 201, 202, 203. Three leucocytes which have absorbed pieces of larval muscle and are degenerating among the "wing" muscles (×2000, ×1500, ×1500, respectively).

PLATE XXIX.

Fig. 204, a, b, c. Three gorged leucocytes which, after feeding, have "retired" to a cavity of a hollow appendage—eight-hour pupa (×2000).

Figs. 205, 206. Similar leucocytes, which could not survive their meal, and are disintegrating- eight-hour pupa (×1500).

Fig. 207. A leucocyte in four and a half day pupa degenerating (×1500).

Fig. 208. A leucocyte of imago, which is recovering from its meal—fifty-two hour pupa (×1500).

Fig. 209. A leucocyte from four and a half day pupa which has entirely recovered (×1500).

Fig. 210. A nucleus from integumental cell of defaecating larva, showing crystals within the great nucleolus (×2300).

Fig. 211. "Heart" of adult larva (×420).

Fig. 212. Posterior end of same, showing ostia (×800).

Fig. 213. Section through heart and adjacent structure of larva twelve hours before defaecation. Note the delicate cellular pericardium outside the heart. Note also the proliferating anlage of dorsal abdominal glands (*cf.* fig. 173) (×800).

Fig. 214. Median longitudinal section along dorsal body wall, to show metamorphosing "heart." The integument and larval cuticle are also shown. The small imaginal and hypertrophied larval cells are easily distinguished. Note especially the proliferation of cells along ventral portion of heart. A few leucocytes (l) are lying within the heart—defaecating larva (×1000).

Fig. 215. The same. Numerous embryonic cells extending upwards in a solid column, and overwhelming the hypertrophied larval cells (×1000).

Fig. 216. The wall of heart, showing the large larval cells and small embryonic cells advancing upon them (×1000) defaecating larva.

Fig. 217. Section through dorsal body wall of larva six hours after defaecation, showing embryonic cells at base of regenerated heart tube (×500).

Fig. 218. The same, in a more anterior part of the heart. Note the embryonic cells enveloping the regenerated heart tube (×1200).

Fig. 219. Regenerated heart (aorta) from fresh pupa (×1000).

Fig. 220 Posterior (contractile) part of dorsal vessel (heart), showing the striated muscle cells.

Fig. 221. A peripheral nerve from posterior end of defaecating larva. Note larval imaginal elements in the splanchnopleural nerve sheath (×800).

Fig. 222. The same in metamorphosis Note dividing imaginal cell (×2000)—defaecating larva.

Fig. 223. The same, showing globular degeneration of the fibres within the nerve (×2000)—defaecating larva.

Fig. 224. Nerve cell from brain of imago (×1500).

Fig. 225, a, b, c, d, e. Stages in the fusion of ganglia in the ventral nerve cord during the early hours of pupation. Semi-diagrammatic.

Fig. 226. A regenerated nerve ending on a muscle fibre in the rectum—four and a half day pupa (×1000).

PLATE XXX.

Fig. 227. Longitudinal section through a metamorphosing thoracic ganglion, from defaecating larva. Note masses of dead tissue. Several imaginal cells are dividing by mitosis (×900).

Fig. 228. Five nerve cells from thoracic ganglion, eight hours after defaecation. Two are developing nerve fibres (×1500).

Fig. 229. Metamorphosing neuroglia network of ventral nerve cord (×900).

Fig. 230. Transverse section through brain of first larval instar, showing larval and imaginal elements (×700). The apparently greater size of the imaginal cells is due to the fact that most of the cell substance in the larval cell is contained in the nerve fibres.

Fig. 231. Dorsal view of brain of adult larva (×190).

Fig. 232. The same, from fresh pupa. Note development of optic ganglia, and the migration of first ganglia of ventral nerve cord (×190).

Fig. 233. Brain of pupa, twenty-six hours old, view from in front and from slightly below. Note incorporation of first ventral ganglion into the brain (×190).

Fig. 234. Brain of imago, view from front. The right hemisphere is represented as if the anterior portion were dissected away, revealing the nerve strands at the rear of the brain (×190).

Fig. 235. Section through metamorphosing brain tissue (eight hours after defaecation (*cf.* fig. 77). Notice the mass of dead tissue; also the degenerate nerve strand. Imaginal elements are proliferating (×1100).

Fig. 236. Transverse section through half of the brain (twenty-four hour pupa), showing regenerated nerve strands, ganglia, etc. (×190).

Fig. 237. Neuroglia network within ocellar nerve strand of brain—twenty-four hour pupa (×900) (*cf.* fig. 236).

A PRELIMINARY NOTE ON THE FOSSIL WOODS FROM SOME AUSTRALIAN BROWN COAL DEPOSITS.

By E. DOROTHY NOBBS, B.Sc.,
Research Scholar in Botany, University of Adelaide.

[Read October 19, 1922.]

The South Australian brown coal deposits at Moorlands have recently been the subject of geological investigation,(1) but the plant remains they contain have not as yet been examined botanically. It therefore seemed that a study of the plant constituents of this material might prove of interest. A quantity of material was made available for investigation by Mr. A. C. Broughton, manager of the Moorlands Mine, whom I take this opportunity of thanking.

For comparison with the material from Moorlands a collection of woody fragments was obtained from the brown coal deposit uncovered this year at Yallourn, Gippsland, Victoria.

My thanks are due to Professor Osborn, Department of Botany, University of Adelaide, for the interest he has shown throughout the course of the work. It had been intended to carry the investigation further, but, circumstances having arisen that will prevent my doing so, the results are given here as far as they go.

MATERIAL FROM MOORLANDS.

The coal consists of a matrix in which are embedded fragments of lignite often of considerable size. Occasional layers of black shiny coal are noted, also lumps of a jet-like substance thought to be resin. Several specimens of coal show a laminated structure, between the layers of which are numerous leaf cuticles and other leaf fragments,(2) all of which appear to be Dicotyledonous types. It was, however, thought advisable to confine the present investigation to an examination of the structure of the "wood," since it has been shown that leaf impressions and leaf cuticles alone are of doubtful value(3) in generic determinations of Tertiary plants. The woody material was separated out from the matrix, and after suitable treatment it was found possible to obtain good microtome as well as free-hand sections.

Forty-five distinct pieces of wood were obtained. These show varied states of preservation, but a large number were sufficiently well preserved to be determinable. Of the 45 fragments, 23 showed Coniferous characters, while 4 proved to be Angiosperms. The remaining 18 fragments were too poorly preserved to allow sectioning. The 4 Angiosperms have not given sufficient data to admit of identification, though it is probable that there are two species represented. Of the 23 fragments definitely Gymnosperms, only two have structural features sufficiently preserved for detailed description.

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(1) Broughton, A. C.; also Mawson, Sir D., and F. Chapman.

(2) Broughton, A. C., *l.c.*, p. 252.

(3) Seward, vol. iv. Andrews, 1916.

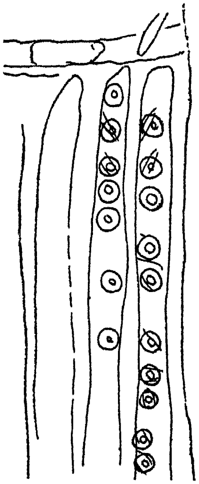

Fig. 1.
Mesembrioxylon, sp. Moorlands A. Radial section showing the tracheal pitting. ×275.

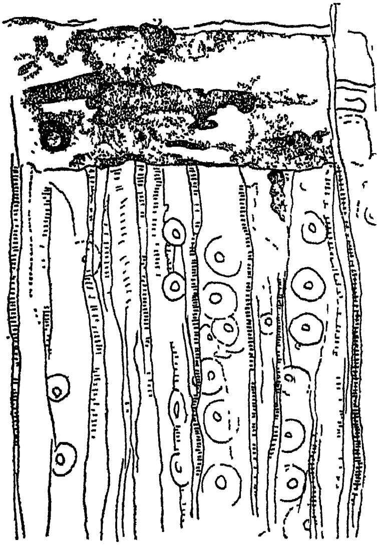

Fig. 3.
Mesembrioxylon, sp. Moorlands B. Radial section showing tracheal pitting. ×275.

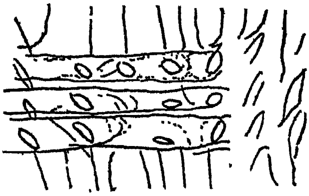

Fig. 2.
Mesembrioxylon, sp. Moorlands A. Radial section showing the pits in the field. ×275.

DESCRIPTION OF SPECIMENS.

MESEMBRIOXYLON, sp.

Moorlands A (figs. 1, 2).

The state of preservation is good. The lumen of the tracheids is not obscured by brownish matter nor do the rays contain any dark-brown substance.

Growth rings are clear

Bordered pits uniseriate, separate, and circular (fig. 1).

Medullary rays uniseriate, two or three cells high, occasionally four or five. The cells are free from dark-brown contents. There may be one or two oval, oblique, apparently simple pits in the field (fig. 2). The presence of pits on the horizontal and tangential walls of the rays is well known to be a difficult character to determine,(4) and negative

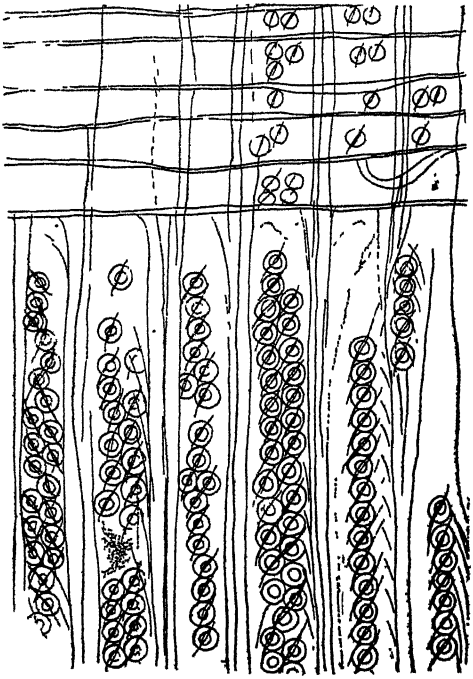

Fig. 4.

Mesembrioxylon, sp. Yallourn A. Radial section showing pits in the field and tracheal pitting. ×275.

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(4) Seward, vol. iv., p. 169.

evidence is unsatisfactory; however, pits do not seem to be present.

No *rims of Sanio* are apparent.

MESEMBRIOXYLON, sp.

Moorlands B (fig. 3).

A considerable amount of compression has taken place in certain regions of this specimen. The medullary rays and the lumen of the tracheids are filled with brown contents.

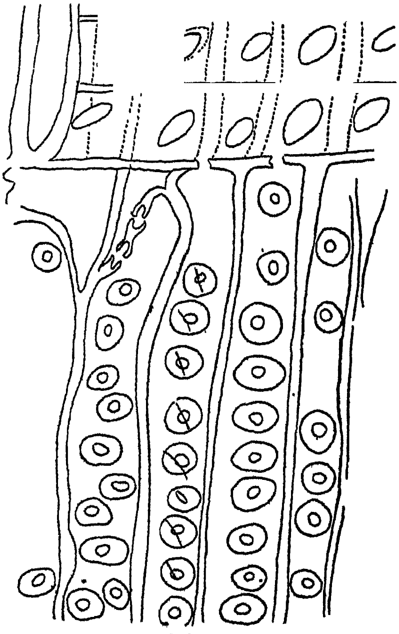

Fig. 5.

Mesembrioxylon, sp. Yallourn B. Radial section showing pits in the field and pitting on the radial and oblique walls of the tracheids. ×275.

Growth rings are present.

Bordered pits uniseriate, separate, and circular (fig. 3), only showing in regions of better preservation.

Medullary rays uniseriate, two or three cells high, rarely four or five. Many ray cells have dark-brown contents.

The pitting in connection with the medullary rays is not preserved.

Rims of Sanio not observed

It would appear that there is a close affinity between the two specimens. A resemblance to the living genus *Callitris* is evident, but until further material and more data are available it seems inadvisable to definitely imply an affinity with a particular existing genus purely on the evidence of the wood. It seems, from the characters described for both specimens, that they are best included under the genus *Mesembrioxylon* instituted by Professor Seward.(5)

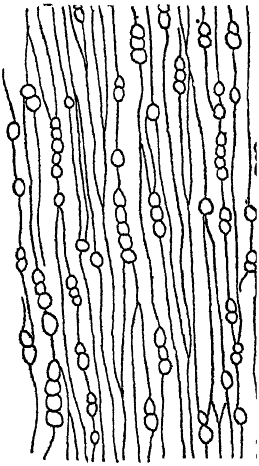

Fig. 6.

Mesembrioxylon, sp. Ya lourn B. Tangential se tion showing medulla rays. ×55.

MATERIAL FROM YALLOURN, GIPPSLAND, VICTORIA.

This material is in a much better state of preservation an exhibits several features of interest.

Eleven different wood specimens from Yallourn have bee examined, but only sufficiently complete data have bee obtained to justify description of four. One Angiosperr was recognizable, while the remainder were undoubtedl Gymnosperms.

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(5) Seward, vol. iv., p. 203

DESCRIPTION OF SPECIMENS.

MESEMBRIOXYLON, sp.

Yallourn A. (fig. 4).

This wood shows well-defined *growth rings*. Tracheids or xylem parenchyma containing dark-brown matter were not observed.

Average diameter of the tracheids is 45μ.

Bordered pits are in one or two rows, contiguous but not compressed. Where the pits are in two rows they are alternate or subopposite (fig. 4). Pits occur occasionally on the tangential walls of the tracheids.

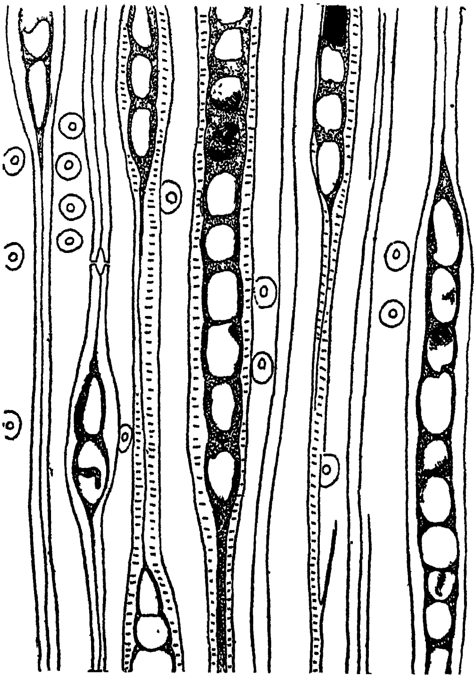

Fig. 7.

Cupressinoxylon, sp. Yallourn. Tangential section showing medullary rays and occasional pitting on tangential walls of tracheids. ×275.

Medullary rays simple, uniseriate, usually from one to eight cells high, occasionally ten. Some of the ray cells contain dark-brown matter. There are from one to four circular pits in the field in connection with the rays. These pits have narrow oblique slits (fig. 4).

Spiral bands appear on the tracheids, but no *rims of Sanio* were observed.

Apparently there is no *xylem parenchyma*.

MESEMBRIOXYLON, sp.

Yallourn B (figs. 5, 6).

Growth rings are well defined in this wood. No tracheids or xylem parenchyma with dark-brown contents were found.

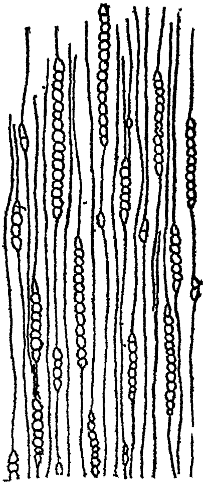

Fig. 8.

Cupressinoxylon, sp. Yallourn. Tangential section showing medullary rays. ×55.

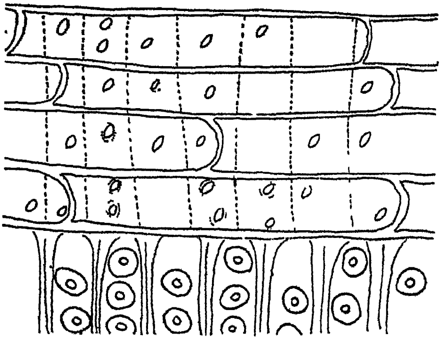

Fig. 9.

Cupressinoxylon, sp. Yallourn. Radial section showing pits in the field and pitting on the tracheids. ×275.

The average diameter of the tracheids is 30μ.

Bordered pits are circular, separate, and scattered, usually in one row. Occasionally the pits are slightly flattened (fig. 5).

Medullary rays are uniseriate, from one to eight cells high, occasionally more than eight cells (fig. 6). The ray cells are large and thick-walled. The pitting in connection with the medullary rays is well preserved, there being one large oblique pit in the field (fig. 5). Occasionally the pit may have the appearance of a border.

CUPRESSINOXYLON, sp.

Figs. 7-9.

Growth rings are well defined here. Many cells have the lumen filled with dark-brown matter The medullary rays are close together and have light-brownish contents with occasional "resin-spools."

The average diameter of the tracheids is 20μ

Bordered pits are uniseriate, separate, and circular. The spring wood may show two rows of pits on a few tracheids. Pits also occur scattered on the tangential walls (fig. 7)

Medullary rays simple, uniseriate, and numerous throughout the wood (fig. 8). They are usually from one to twenty cells high. At times they may reach a height of thirty cells. Some of the ray cells have contents. The pits in the field are one or two oval and oblique, and there may be the appearance of a border (fig. 9).

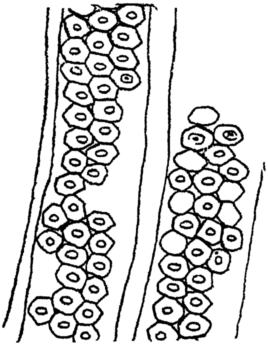

Fig. 10.

Dadoxylon, sp. Yallourn. Hexagonal pitting on radial walls of the tracheids. ×275.

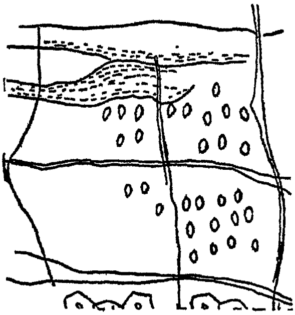

Fig. 11.

Dadoxylon, sp. Yallourn. Numerous small pits in the field. ×275.

Xylem parenchyma is present with resinous (?) contents.

The general characters, especially the pitting, in connection with the medullary rays, and the presence of wood parenchyma, suggest that this specimen should be included under *Cupressinoxylon*.

DADOXYLON, sp.

Figs. 10, 11.

This is a roughly cylindrical piece of wood, oval in cross section, with the outer cortex preserved and remaining attached to the woody cylinder. The long diameter of the whole is about 2·5 cm. The cell detail of the specimen is not well preserved, but the following details can be determined:—

In transverse section many cells have the lumen filled with brown matter. Occasional irregular strands of parenchyma occur in the wood in places, but their nature could not be determined.

Growth rings are present

Bordered pits on the radial walls of the tracheids are in two or more rows, alternate, compressed, and hexagonal.

Medullary rays simple, uniseriate, from one to eight cells high. Radial sections show numerous small oval pits in the field. Horizontal elements filled with dense dark-brown substance occur in association with the rays.

CONCLUSION.

It would appear that considerable Gymnosperm forests have contributed to the formation of the brown coal deposits of Moorlands, South Australia, and Yallourn, Victoria. Such forests do not occur in South Australia or Victoria to-day though there are occasional open forests of *Callitris* growing under semi-arid conditions. No mixed Coniferous forests exist in these parts, yet these must have given rise to the Yallourn lignites which have yielded several distinct types of Gymnosperms, namely, two species of *Mesembrioxylon*, one *Cupressinoxylon*, and one *Dadoxylon (?)*. The Moorlands forests would appear to have been more uniform, so far as preservation of the wood allows one to say. In view of the abundance of Dicotyledonous leaf fragments from Moorlands, the scarcity of Dicotyledonous wood is strange.

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ON A NEW GENUS AND SPECIES OF AUSTRALIAN LYCAENINAE.

By NORMAN B. TINDALE.

(Contribution from the South Australian Museum.)

[Read October 19, 1922.]

PLATE XXXI.

ADALUMA, n. gen.

Forewing with vein 11 parallel with vein 12, vein 6 arising with vein 7, veins 1 to 7 (in male) bordered discally with black scales, costa strongly arched; termen well rounded. Hindwing evenly rounded, apex of cell acute, vein 3 arising some distance below apex of cell Beneath white, with terminal series of dots. Antennae short, less than half expanse of wings. Eyes smooth, palpi long. Type, *A. urumelia*, from the Northern Territory.

Allied to *Candalides*, Hubner, to which it is similar in venation. The shape of the cell of hindwing differs from *C. xanthospilos*, Hubner, in being more acute at apex The antennae are extremely short; in this character it resembles the peculiar genus *Nesolycaena*, from which otherwise it is distinct.

The names chosen, "adaluma" and "urumelia," are two native (Nungubuyu tribe) words meaning "flowing stream" and "butterfly." The butterfly was first taken on the banks of the Roper River by a native, at the aborigines' reserve, which is over 70 miles from the sea.

ADALUMA URUMELIA, n. sp.

♂. Above. Forewing silky-white tinged with blue; apex and termen narrowly grey-black, veins tipped black at termen; veins 1 to 7 bordered with black scales in discal area. Cilia black, tipped with white. Hindwings silky-white, a terminal line black. Cilia black, tipped with white.

Beneath. Silky-white. Forewing with two large terminal black spots in areas 1a and 2; terminal line black. Hindwing with a terminal series of round black dots, terminal line black. Cilia black, tipped with white, at dorsum white. Antennae short, well clubbed, joints short, black, tipped with white; palpi long, tipped with black. Expanse, 30 mm.

Loc.—Northern Territory: Roper River, March, 1922 (Mrs. H. E. Warren and a native). Type, I. 13771.

This species is known from two males, one fragmentary, but the other perfect. Following Waterhouse and Lyell,⁽¹⁾ in a linear arrangement, it would be best placed between *Nesolycaena* and *Philiris*.

EXPLANATION OF PLATE XXXI.

Fig. 1. *Adaluma urumelia*, male, upper-surface, ×3.
,, 2. ,, ,, ,, under-surface, ×3.

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(1) Waterhouse, G. A., and Lyell, Butterflies of Australia, p. 76, 1914.

ON THE ECOLOGY OF THE OOLDEA DISTRICT.

By R. S. Adamson, M.A., B.Sc., and T. G. B. Osborn, D.Sc.

[Read October 19, 1922.]

Plates XXXII. to XXXVI.

Comparatively little has been written about the ecology of the arid regions of Australia, though these form a large portion of the continent. In South Australia, which has an area roughly three times the size of the British Isles, five-sixths of the total area has under 10 in. of rain per annum. A vast field, therefore, is awaiting examination. One reason that has contributed to the neglect of this work is the difficulty of visiting the places and the time occupied in the journey. The recent opening of the Transcontinental (East-West) Railway connecting South and Western Australia has made very accessible an area that until the last few years was visited by but few white people. The Ooldea district lies well within this area, and offers scope for examining the arid flora, the more so that, owing to an abrupt change in the type of soil in the immediate locality two distinct habitats are available. Cannon visited Ooldea recently in connection with his work on the Arid Flora of South Australia, but his account was brief, and no attempt was made by him to deal with the flora as a whole.

Ooldea is a station on the Transcontinental (East-West) Railway, 427 miles west of Port Augusta and 374 ft. above sea level. The Ooldea district is one of great biological interest because of its situation on the eastern boundary of the Nullarbor Plain, at the point at which the railway line leaves the sandhills and runs over the limestone plains. In August of this year we made a stay of six days in the district, and as a result of this visit the following account of the vegetation is given. It is a pleasure to express our thanks to the President and members of the Ooldea Progress Association for the facilities they placed at our disposal; to Mr. T. Davison, engineer at the "Soak," for his guidance in that area; and to Mr. A. G. Bolam, stationmaster at Ooldea, for meteorological data and help in various ways. We are also indebted to Mr. J. M. Black, who has determined some of our material for us. Mr. J. H. Maiden, F.R.S., has kindly named the Eucalypts.

PHYSIOGRAPHIC.

The Nullarbor Plain is an area of limestone country extending westward from Fowler Bay to beyond Eucla in Western Australia. Its east-west extent is 450 miles and its greatest north-south width about 200 miles. The area within South Australia is 17,767 square miles, throughout the whole of which there is no watercourse or lake It is underlain, however, by the Eucla basin of artesian water which has been tapped by bores at depths varying from 298 ft. to 1,500 ft. A bore sunk at Ooldea gave water at 480 ft., containing 7·716 ozs. of salt to the gallon.(1)

Little has been written on the geology of the area, the account by Tate,(2) who visited the seaward margin of the Nullarbor Plain in 1879, being still the most complete.

The Nullarbor Plain forms a part of the Bunda Plateau, which, according to Tate, is the "elevated bed of the older Tertiary sea, the sediments of which were deposited within a very extensive granitic basin." These igneous rocks come to the surface at various places round the edge of the basin, an outcrop occurring to the east of Ooldea. According to Howchin(3) the limestones are Miocene (Janjukian), overlain by older Pliocene (Kalimnan), at Wilson Bluff, near Eucla.

The surface of the plain is not perfectly level, but rises and falls in gradual undulations.(4) The limestone is covered by a red sandy loam varying from a few inches to a foot or more in depth, which soil, being fine grained, bakes hard when dry. Fragments of limestone, however, are freely interspersed with the soil, and appear at the surface in most places, especially on the ridges.

Here and there are "dongas," or slight depressions varying in area from less than an acre to some hundreds of acres. The dongas are said to be the largest at the western side of the plain. Those seen by us were small; they are said to be infrequent in the centre of the plain. The soil in the dongas is sandy and of greater depth than on the plain, and, in those seen by us, free from limestone. In addition to the dongas there are numerous "blow holes," fissures of varying depth in the limestone, that open in many cases into caves below. It seems probable that the dongas represent areas of subsidence.(5) The whole structure of the plain is such that the rain which falls readily disappears below the surface. Only in the dongas is there sufficient soil to hold an appreciable water reserve; the soil of the plains is too shallow.

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(1) Rep. 3rd Interstate Conference on Artesian Water, Adelaide, 1921, p. 16. Adelaide, Govt. Printer, 1922.

(2) Tate, R., The Natural History of the Country around the Head of the Great Australian Bight, Trans. and Proc. Philos. Soc. of Adelaide, S. Austr., ii., pp. 94-128, 1879.

(3) Howchin, W., "Geology of South Australia," pp. 157 and 466, Adelaide, 1918.

(4) A quantity of interesting information as to the Nullarbor Plain is collected as a supplement to the Presidential Address to the South Australian Branch of the Royal Geographical Society, session 1917-18. Proc. Roy. Geol. Soc. S. Austr., xix., pp. 101-153, 1919.

Starting at Ooldea and running eastwards for about 50 miles is a sandhill region, consisting of a series of ridges of red-coloured sand with flats between. The ridges, which may be as much as 30 ft. in height, run approximately north-west by south-east at Ooldea, but there are many irregularities and connecting ridges. The sand forming the ridges is relatively stable and no drifting of large masses occurs. Indeed, some, at any rate, of the larger ridges have a core of travertine limestone 3 ft. or so below the surface. The soil of the intervening flats is generally level and composed of finer particles, and is consequently firmer. This soil, on the whole, appears deeper than on the ridges themselves Whatever be the source of the sand, it is clear that a certain amount of wind sorting has taken place, with the result that over the whole area two habitats differing in their edaphic conditions have been developed.

About three miles north of Ooldea lies the famous Ooldea Soak. This is a shallow basin, 10 acres or more in extent. The sand of the Soak and its surrounding ridges is whiter and less stable than that of the majority of the sandhills; it rests upon an underlying layer of bluish clay. Within the area there is considerable drift, so that the floor of the basin is broken by various hollows and ridges held by shrubs. Below the surface, at a depth of 5 ft. to 15 ft. or more, lies a water table, the water being fresh, somewhat alkaline, but generally quite potable. The Soak has been the scene of human activities for a great period of time, for it was known to the aborigines long before the explorer, E. Giles (who was one of the first whites to visit it), used it as a base camp in 1875.(6) Later it was used as a centre for sheep grazing,(7) but appears to have been abandoned for that purpose some time before the building of the Transcontinental Line made it a place of importance. At present over twenty wells have been put down within the area, and water is pumped to Ooldea at the rate of 10,000 gallons a day. It is legitimate to assume that the vegetation within the Soak basin has suffered somewhat from human interference, and it may suffer still more if pumping permanently lowers the water level. Mr. Brown, referring to his visit about 1887, speaks of "clumps of bullrushes" growing here and there. None are there now, while of the plants collected by us only *Adriana tomentosa*—locally called "water-bush"—seems definitely indicative of considerable edaphic water. Within half a mile of the Soak, in a north-easterly direction, lies a salt lake or claypan, smaller in area than the Soak itself. This was dry at the time of our visit, but the friable soil overlying the claybed was impregnated with crystals of soluble salts, including gypsum, that caused a white efflorescence at the margins.

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(5) Brown, H. Y. L., quoted Proc. Roy. Geog. Soc. S. Austr., *loc. cit.*, p. 134.

(6) Giles, E., Australia twice Traversed, ii., p. 152, 1889.

(7) Brown, T., Proc. Roy. Geog. Soc. S. Austr., *loc. cit.*, p. 149.

CLIMATE.

Climatological data for Ooldea were not kept before December, 1916, because, until the construction of the East-West Railway, there was no settlement at the place. From that date rainfall records have been kept, the temperatures have been recorded less regularly. The actual figures cover too short a period to allow of generalization on them alone, but, taken in conjunction with what is known of other places similarly situated, they are useful.

The following table gives the rainfall in inches from January, 1917, to October, 1922:

	1917.	1918.	1919.	1920.	1921.	1922.
January ...	2·50	0·00	0·70	0·00	0·03	0·00
February ..	1·15	0·00	1·63	0·00	2·83	0·59
March ...	1·18	1·00	0·00	0·08	0·28	0·71
April ...	1·24	0·60	2·11	1·00	0·01	1·27
May ...	0·51	0·63	0·06	1·39	2·13	0·25
June ...	1·49	1·06	0·25	0·45	0·91	0·74
July	1·48	0·16	0·16	0·68	0·15	0·25
August ...	0·22	1·19	0·57	0·69	0·15	0·00
September ...	0·76	0·29	0·08	2·32	0·03	0·00
October ...	1·69	0·72	0·54	0·64	0·36	0·15
November ..	1·16	1·31	0·20	0·49	0·93	—
December ...	0·73	0·39	0·33	0·42	0·35	—
Total for Year	14·11	7·35	6·63	8·16	8·16	*3·96
Wet Days ...	65	30	27	47	43	*27

*Totals for 1922 on figures for 10 months only.

The monthly average temperatures in degrees F. at 9 a.m. and 4 p.m. are given below, no maximum and minimum readings being available:—

	Jan	Feb.	Mar	April	May	June	July	Aug	Sept.	Oct	Nov.	Dec.
9 a.m.	70	65	74	55	52	45	48	49	57	58	65	75
4 p.m.	105	104	99	90	89	75	65	89	90	95	103	106

The highest shade temperature recorded is 125° F., which occurred in January.

The rainfall is not only low but erratic. Though, broadly speaking, the summer is the dry season and the winter the wet one, the falls at best are too low to make the winter always a season of active vegetation, whilst a heavy downpour in the summer may have a marked effect in producing considerable activity on the part of some of the annuals at least. Owing to the very porous soil the rain sinks into the ground as it falls, there being no sign of a watercourse in the district.

Another feature in regard to the rainfall is the amount that falls at any one time. Though the monthly total may seem relatively high, if it be composed of a number of small showers, as is often the case in arid Australia, the general effect on the vegetation is slight. Cannon has drawn attention to what he terms effective and ineffective rainfalls in arid South Australia, a fall of 0·15 in. in twenty-four hours being insufficient to produce more than a surface wetting of the soil. This important feature, which is recognized by Australian pastoralists, must be remembered when considering the monthly falls at Ooldea or any other station in this part of arid Australia.

The temperature records show the climate to be one of considerable extremes. Short periods of great heat, over 100° F. in the shade, may be expected during six months of the year, while the average daily temperature at 4 p.m. Nov.-Feb. inclusive is 103° F. or over. The area, however, is so open that heat is rapidly lost by radiation at night, even in summer, while in winter the diurnal range of temperature on the soil between sun heat of the day and at night is still more severe. Ground frosts are not uncommon on clear nights during three or four months of the year. No records of temperatures at the surface of the soil have been taken, but it is certain that they must reach very high figures, especially during the summer. In August, at the time of our visit, on a day on which there was a frost upon the ground before sunrise, the sand at midday was so hot in the sun that it was uncomfortable to touch it with the hand. In summer the heat at the surface of the soil must be so great as to seriously affect plants unless they are well insulated at the "collar" by cork or some other nonconductor. In this connection it may be noted that perennial herbaceous plants are noticeably rare in the Ooldea flora. Another adverse factor is the drying winds which sweep over the plain. Ooldea is 80 miles from the sea, and the intervening country is similar waterless plain or sandhill. Even the south and south-west winds have their humidity reduced before reaching Ooldea, while any other wind travels considerably further overland before it gets to that place. All winds, but especially those off the deserts that lie north and north-east and north-west, must be regarded as influences operating adversely to the vegetation.

Previous Work on the Flora.

The paper of Tate before mentioned includes a list of the flora at the head of the Bight as well as some notes on the vegetation. The region traversed by him, being near the coast, has a higher rainfall than Ooldea, and also gains considerable moisture from sea mists for a distance inland of 20 miles.(8) Nevertheless, the vegetation seems essentially similar. Tate's(9) notes on the flora are valuable, especially noteworthy being the clear distinction that he makes between such halophytes as *Arthrocnemum* spp., and xerophytes as *Kochia sedifolia*. Saltbushes, *Atriplex* spp., are assigned an intermediate position; they show considerable salt toleration, but not to the same degree as the truly halophytic shrubby Salicornias.

The Ooldea region has been studied floristically recently by Black.(10) Cannon visited the district in 1918, and his observations are included in his recent work on the "Arid Portions of South Australia." No attempt is made(11) by Cannon to give a complete account of the flora, but the main habitats are studied with reference to some of the most prominent plants occurring there. Cannon distinguishes the Nullarbor Plains, the sandhills, and a transition region between the two; the dongas and the hollows between the ridges in the sandhills are also indicated as probably distinct. With his account we are in general agreement, except that the characteristic bluebushes and saltbushes of the plains are classed by him as halophytes. With this we disagree.

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(8) Brown, T., *loc. cit.*, p. 147.

(9) Tate, R., *loc. cit.*, pp. 118-121.

(10) Black, J. M., Trans. Roy. Soc. S. Austr., xli., pp. 378-390, 1917, and xlv., pp. 5-24, 1921.

(11) Cannon, W. A., Plant Habits and Habitats in the Arid Portions of South Australia, Carnegie Inst. of Washington, Publ. No. 308. 1921, pp. 81-89.

VEGETATION.

At least two very markedly different kinds of habitat occur near Ooldea, namely, the Nullarbor Plain and the sandhills. These will be described separately.

Nullarbor Plain.—The plain itself bears a very open vegetation of a highly xerophytic character. The soil being of a porous nature, and one which does not easily form a dust mulch, the water supply for vegetation is scanty and very uncertain in amount This is clearly expressed in the sparse plant covering. On the plain itself trees or woody plants of any size appear to be absent.

The chief plants are the "bluebush," *Kochia sedifolia*, and in rather less quantity the "saltbush," *Atriplex vesicarium*, which occur in communities which are often sharply delimited from one another. Other species of *Kochia* and of *Atriplex* also occur, but in less quantity, *e.g.*, *K. triptera*, v. *erioclada*, *K. pyramidata*, etc.

These plants, which we may term the "character plants," are small bushes, 1 ft. to 2 ft. in height, which stand in most parts at considerable distances from one another—often as much as two to three yards (pl. xxxii , fig. 1). In spite of this condition, however, in which the plants develop quite independently of their neighbours, the communities are usually quite pure as regards their character species. *Kochia sedifolia* is much more common than *Atriplex*, and covers a much greater area of the plain. It occupies nearly all the surface where the fine-grained red soil occurs, while *Atriplex vesicarium* occurs in those parts where some sand is present or the soil is deeper and looser. The latter is especially abundant near the eastern margin of the plain and along the line of junction with the sandhills. So far as our observations extend, *Kochia* would appear to be more xerophytic, or, at any rate, able to withstand drier conditions. This agrees with the observations of Tate,(12) who describes the plateau near Eucla as covered with *Kochia*, while *Atriplex* occurs in slight depressions around, but not extending into, saline swamps. These Chenopodiaceous bushes, which have their leaves more or less densely covered with hairs or scales, appear white or silver-grey in colour, and, growing as they do in a soil that also appears pale owing to the numbers of limestone fragments, give a landscape at once characteristic and peculiar. The observer has a sense of uniformity and vastness which is unbroken by any marked change in the surface or by any sign of life, either bird or animal.

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(12) Tate, Trans. Phil. Soc., Adel., vol. ii., p. 120, 1878.

The plants have rather small leaves, which are spreading, and, especially in *Kochia sedifolia*, distinctly succulent. It seems possible that these plants not only store up water in their leaves when rain falls, but also possess the power of absorbing moisture directly by their leaves by means of the hairs or scales. All the residents, both here and in other arid parts of the State, remark on the obvious freshening up of the bluebush or saltbush that occurs immediately after rain. On the other hand, the hairy covering may well be correlated with the intense light and heating that the plants in such a habitat have to withstand.

The severity of the conditions for perennial plants here is expressed both in the open nature of the communities and also in a striking way by the amount and number of dead plants that occur (pl. xxxii., figs. 1, 2). Whole stretches may be seen, extending a mile or more, in which all the perennials are dead, presumably killed by drought. No evidence of fire was noticed, not even in the neighbourhood of the railway track, and, except at the margins of the plain, little effect has been produced by the ubiquitous rabbit.

Besides these perennial plants a very considerable number of annual species occur on the plain between the bushes of *Kochia* and *Atriplex*. The amount and nature of these annuals vary according to the season at which the rain falls, and at certain times may temporarily alter the whole general appearance. At the time of our visit very little rain had fallen for some time previously, and this therophyte flora was poorly developed. One of the most abundant annuals was *Salsola kali*, var. *strobilifera*, which at this season was dead. The plant occurs in great abundance in parts, and appears especially to spread where the Kochia has been killed off. Other very generally distributed annuals were *Cephalipterum Drummondii*, *Zygophyllum ovatum*, *Angianthus tomentosus*, *Gnephosis cyathopappa*, *Goodenia pinnatifida*, *Goodenia pusilliflora*, *Helipterum pygmaeum*, *Lepidium phlebopetalum*, *Echinospermum concavum*, *Isoëtopsis graminifolia*, and *Tetragonia expansa*, also *Bassia scleroloenioides*, perennial. Of these the first two were the most abundant or most prominent. *Cephalipterum* especially, with its white flower-heads, gave quite a character to the plains.

At the time of our visit grasses were remarkable for their scarcity; a few scattered plants of *Danthonia penicillata* and *Stipa setacea* and *Stipa scabra* were noticed, but so few that nowhere on the plain was grass vegetation at all prominent. At other times these grasses, and especially *Stipa*, sp., may become a marked feature after good rains. At the time of our visit most of the *Stipa* plants noted were dead.

Dongas.—These are shallow depressions of varying size and extent which occur scattered over the plain. Except in the smallest and most shallow, there is a considerably greater quantity of soil in them—a soil, too, which is much freer from limestone fragments.

The dongas examined, which, however, were all comparatively close to the eastern border of the plain, bear a vegetation with trees or shrubs (pl. xxxii., fig. 1). The most general were species of *Acacia*, especially *A. aneura* (mulga), *A. Oswaldii*, *A. tetragonophylla*, with less often *A. Randelliana*.

Other trees occurring were *Pittosporum phillyraeoides*, *Fusanus persicarius*, and locally *Casuarina lepidophloia*. This last was seen only in the largest depressions where there was most soil. *Eremophila Latrobei* occurred rarely. Beneath these trees the soil was quite bare in the smaller depressions, but in the larger ones herbaceous plants (mostly annuals) were present in some quantity. These were generally quite different from those on the general surface of the plain; *Cephalipterum Drummondii*, however, was usually present. *Stipa scabra* was locally quite abundant, though at this season it appeared dead.

Other annuals found in these dongas were *Salsola kali*, *Lavatera plebeja*, *Convolvulus erubescens*, *Lotus australis*, var. *pubescens*, *Helipterum floribundum*, *Nicotiana suaveolens*, *Calandrinia volubilis*, *Pimelea simplex*.

In several of the dongas near the eastern margin of the plain much of the undergrowth has been destroyed by rabbits, which have their burrows there.

At the eastern margin of the Nullarbor Plain a certain amount of change in vegetation is seen. More soil is present and a richer vegetation develops. Small trees and shrubs occur scattered over the surface, though often localized in a peculiar way (pl. xxxii., fig. 2). Most of the shrubs found in the dongas grow in this situation, with the exception of *Casuarina lepidophloia*. The most abundant shrubs are *Acacia aneura*, *A. tetragonophylla*, and *Eremophila Latrobei*, with *Acacia Randelliana*, *A. Oswaldii*, *Pittosporum phillyraeoides*, *Fusanus persicarius*, and *Eremophila oppositifolia*, less frequently. Here also the undergrowth is rather more luxuriant; *Kochia sedifolia*, *Atriplex vesicarium*, and others occur somewhat closer together. The annual flora resembles that of the plains themselves, but certain perennial plants appear in this zone, *e.g.*, *Solanum esuriale*, *S. coactiliferum*, *Sida corrugata*. On disturbed ground near the village *Calandrinia polyandra* and *Euphorbia Drummondii* are found in some quantity.

Sandhills.—The vegetation of the sandhills to the east of Ooldea is a marked contrast to that of the Nullarbor Plain. In place of the dwarf grey or white Chenopodiaceous bushes of the latter, the sandhills bear a relatively luxuriant covering of trees and shrubs. These differ both in their much larger size, and also very much in leaf form. While the plants on the plain have more or less spreading, though small, leaves which are succulent and covered with hairs, almost all the plants on the sandhills have smooth leaves which are hard in texture and placed with their edges to the light, being either pendant or vertical. The leaves are either quite glabrous and polished as in *Eucalyptus*, spp , and *Myoporum*, or grey in colour, due either to wax or to a covering of very small hairs that do not spread from the surface, as in several species of *Acacia*. Even those plants such as *Casuarina*, *Bossiaea*, and others which are almost or quite leafless have their assimilatory branches erect or pendant, not spreading. This leaf character applies both to the larger bushes and trees, and also to the smaller undershrubs which here bear, for the most part, small hard leaves placed more or less vertically This difference in leaf type makes the vegetation on the two parts very distinct, even when seen from long distances (pls. xxxiii., xxxiv., fig. 1, and xxxv.) In both situations it may be remarked that all the plants are evergreen; not a single deciduous plant was found.

For purposes of description the vegetation can be divided into three portions: (1) the sand ridges, (2) the hollows between, and (3) the basin known as Ooldea Soak. Even with this division the vegetation presents at first glance a rather bewildering lack of uniformity; many plants are apparently localized in their distribution, and situations externally very similar often bear different plant populations. This variability can to some extent be explained by a recognition of the fact that the sand is not uniformly stabilized. The plants in different places vary in their efficiency as sand retainers. It may also be correlated with the frequent limitation of areas drenched by rainstorms. These "patchy" rainfalls may make certain places good seedbeds, while the surrounding areas are too dry for a high percentage germination or even any at all that season. The result is that while some sandhills are ablaze with the flowers of an abundant annual flora, others a few miles away are without any appreciable annual growth at all. It is well known to pastoralists that the season at which a soaking rain falls profoundly affects the type of annual flora that results. It seems to us quite legitimate to assume that the germination of other plants is affected also, and hence that different phases of an open flora may be shown under similar edaphic conditions within a short distance of each other, because the climatic factor of rainfall has varied as a result of some fortuitous circumstances, *e.g.*, a local thunderstorm. A further factor affecting this variability is interference by man, which has been not inconsiderable in some places. This interference is partly caused by the aborigines, who cut down and uproot trees and shrubs around their camps in an astonishingly reckless manner, and partly to the demand for wood during the construction of the railway line.

The sand ridges have a rather varied flora, among the most prominent and generally distributed plants on the ridges are *Acacia linophylla*, known as the "sandhill mulga", *A. ligulata*, *Dodonaea attenuata*, and, rather less generally distributed, *Leptospermum laevigatum*, var. *minus*. These, with locally some quantity of *Hakea leucoptera*, *Grevillea stenobotrya*, *Grevillea juncifolia*, and *Bossiaea Walkeri*, mark the earlier stages in the stabilization of the sand. Frequently communities of these plants occupy the crest of the ridge while the sides of it have others which represent the result of a more stable condition. The most prominent of these are mallee forms of *Eucalyptus*. The most common are *E. oleosa*, *E. leptophylla*, and *E. sp. affin. oleosa*, while *E. transcontinentalis* is rather more local. Other plants here are *Acacia Randelliana*, *A. Oswaldii*, *A. aneura*, *Eremophila alternifolia*, and *Cassia eremophila*. In some parts *Callitris verrucosa*, *Grevillea netatophylla*, and *Hakea multilineata* occur in this situation. These last three species were all seen at Immarna, 20 miles east of Ooldea, but not in the immediate vicinity.

On some of the sand ridges near the margin of the plain *Casuarina lepidophloia* occurred both on the sides and even extending on to the crests of the ridge, but this was not general. When the sandhills had become more stabilized the mallee and its associated plants extended over almost the whole, occupying both sides and crests. Indeed, the notable *Eucalyptus pyriformis* seemed only on crests of ridges. Whether the covering consists of *Acacias* and *Leptospermum* or mallees the canopy is not continuous, considerable spaces being left between most of the plants. A marked feature, and one most obvious with the plants on the crests, is the presence of large quantities of dead branches and wood.

Beneath the trees and bushes a moderate amount of undergrowth occurred in some places, though in parts the sand was practically bare. Of perennials, on the crests there occurred *Pimelea microcephala*, *Rhagodia Preissii*, while on the slopes the "porcupine grass" *Triodia irritans* was locally very abundant, forming what appeared at a distance to be a continuous cover; associated with it was *Bassia echinopsila*.

Locally, annuals were abundant on these sand ridges; these were largely composites. The annual flora is strikingly different from that occurring on the plain. On the crests of the ridges, and apparently confined to such situations, were *Calandrinia disperma*, *Stenopetalum lineare*, *Myriocephalus thisocephalus*, *Waitzia acuminata*, and *Podotheca angustifolia*.

Others are less restricted in their habitat, as *Triglochin centrocarpa*, *Trichinium alopecuroideum*, *Calandrinia volubilis*, *Stenopetalum sphaerocarpum*, *Crassula verticillaris*, *Erodium cygnorum* (very local), *Zygophyllum* sp., *Poranthera microphylla*, *Didiscus cyanopetalus*, *Minuria leptophylla* (perennial), *Brachycome ciliaris*, *Angianthus tomentosus*, *Helichrysum ambiguum* (perennial), *H. Lawrencella*, *H. floribundum*, *H. hyalospermum*, *H. strictum*, *H. moschatum*, *H. roseum*, *Senecio Gregorii*, *S. brachyglossus*.

The geophyte *Thysanotus exiliflorus* also occurs here. These herbaceous plants for the most part grow on the sand in the spaces between the bushes and not immediately under them. Below most of the bushes or trees there was an area covered by dead leaves, fruit, branches, etc. This appeared to prevent the development of an annual flora.

Hollows between Sandhills.—While in a general way a distinct flora for sandhill hollows can be recognized, this flora varies greatly in accordance with the amount of sand that is present in the hollow. In nearly all cases the soil is much firmer in the hollows than on the ridges and the vegetation less dense and more easily penetrated, largely owing to the presence of tallish trees in addition to the bushes. The generally most abundant plants are *Myoporum platycarpum*, which is a tree 20 to 30 ft. in height, with *Heterodendron oleifolium*, a bush or small tree. These form the general character plants, but grow in association with many others. Of trees *Pittosporum phillyraeoides* is most abundant, and of bushes *Acacia Randelliana*, *A. aneura*, *A. Oswaldii*, *A. colletioides*, *Eremophila glabra*, *E. Latrobei*, *E. alternifolia*, *Cassia Sturtii*, *C. eremophila*, *Fusanus acuminatus*, *F. persicarius*, *Dodonaea microzyga*. When more sand is present *Casuarina lepidophloia* becomes abundant, growing into large trees, which form an open forest, which will be referred to later. As in all the communities around Ooldea the plants are rarely in close contact with one another, but stand at intervals.

The undergrowth in the hollows is variable both in amount and in composition. In parts it is quite absent, but for the most part some undershrubs or herbs are present. Of the former *Olearia Muelleri* and *Westringia rigida* are the most abundant, together with *Nitraria Schoeberi* and *Zygophyllum fruticulosum*, which are more local

In some parts, and more especially towards the margin of the Nullarbor Plain, where very little sand is present in the hollows, *Atriplex vesicarium* and other species may occur in some quantity, also *Cratystylis conocephala* is abundant. This last is a plant which at first sight bears a most striking resemblance to *Kochia sedifolia*, a resemblance that is emphasized when it is growing with *Atriplex* spp. (*cf* Tate, *loc. cit.*) Other perennials in the undergrowth are *Rhagodia spinescens*, var. *deltophylla*, and *Scaevola spinescens*.

The annual herbaceous flora is much poorer than that of the ridges, and but few species appear limited to this habitat, *e.g.*, *Calotis hispidula*, *Brachycome pachyptera*, and *Trichinium incanum*. Some species, however, are more abundant here, as *Helipterum strictum*, *Tetragonia expansa*, and *Pimelea simplea*; *Stipa*, sp., apparently dead, was also locally abundant, and *Danthonia penicillata* occurred occasionally. When the limestone soil came to the surface in a hollow the annuals of the plain were present.

"Oak" Forest.—Forests of *Casuarina lepidophloia* occur to the south of Ooldea. In this vicinity the forests have been much reduced in quantity owing to the utilization of the timber for condensers and other activities associated with the construction of the railway. At present untouched forest is not met till about seven miles are traversed (pl. xxxiv., fig. 2).

The forest occupies rather flat hollows between sand ridges. The soil, however, is sandy and rather loose all through, even in the centre of the flats. The Casuarinas extend on to the sides of the surrounding ridges but not on to the crests of them, which are covered by *Acacia linophylla*, *A aneura*, and *A. Oswaldii*, *i.e.*, with a typical sandhill crest community.

The forest is a very open one, and the trees are often of considerable size. Measurements of some of them showed a diameter of 26 in. at 1 ft from the ground, and a height of approximately 50 ft. was estimated. When mature the trees have spreading branches, though in the young condition their habit is somewhat strict and pyramidal. Numerous young trees were coming up in the forest. The "oaks" far overtopped any other plants, the other trees present being much smaller; these are *Myoporum platycarpum* and mallees (*E. oleosa*, *E. sp. affin. oleosa*, *E. leptophylla*). The latter occur on the slopes and ridges, and may reach a height as great as *Myoporum*, *i.e.*, 20 ft. to 30 ft. Below, and especially between the trees which nowhere form a continuous canopy, is a considerable assemblage of shrubs or bushes. Of the most prominent are *Fusanus acuminatus*, *F. persicarius*, *Dodonaea attenuata*, *D. microzyga*, *Heterodendron oleifolium*, *Acacia Randelliana*, *A. colletioides*, *A. tetragonophylla*, *A. Oswaldii*, *A. linophylla* (locally), *Cassia Sturtii*, *C. eremophila*, *Eremophila Latrobei*, *E. alternifolia*. As undershrubs there occurred *Olearia Muelleri*, *Westringia rigida*, *and Atriplex vesicarium*, all, however, rather local Annuals and herbaceous plants were not at all prominent, a few individuals only being noticed of *Zygophyllum ovatum*, *Calandrinia volubilis*, and *Helipterum floribundum*.

While the forest of *Casuarina lepidophloia* is rather limited in its distribution around Ooldea, further to the east, as can be seen from the railway, it commonly occupies the sandy hollows, while mallee occurs on the ridges.

The part where the *Casuarina* trees have been cut down shows some signs of regeneration, young trees are springing up in places in some quantity. The other plants of the forest have been left by the timber-getters, and in the cut areas form an open scrub with many more undershrubs than occur in the forest itself. *Atriplex vesicarium* is abundant in parts, and in others *Olearia Muelleri* and *Cratystylis conocephala* form a distinct layer of undershrubs. *Stipa setacea* is also abundant locally. Annuals, too, are more frequent here, though not very prominent. Besides those of the forest there were *Helipterum strictum*, *Helichrysum Lawrencella*, *Angianthus tomentosus*, *Salsola kali*, and *Lepidium phlebopetalum*.

Ooldea Soak.—It will be recalled that the Soak is a basin in the sandhills, itself filled with sand that is thrown into small ridges. This sand is white in colour, not red, and is rather looser in texture than that in other parts. On the sandhills composed of this white sand in the part just around the Soak certain differences occur in the plant population; *Acacia linophylla* is rather less abundant and *Leptospermum laevigatum* more so. Also a certain number of plants grow on this white sand which were not noticed elsewhere. Among these may be mentioned *Grevillea stenobotrya*, *Hakea leucoptera*, *Gyrostemon ramulosus*, and *Eucalyptus pyriformis*.

The basin of the Soak itself has been the seat of some interference owing to man's activities. For centuries this has been a camping ground for aborigines, and in more recent times the white man has utilized it. As a result, a considerable part of the basin is bare sand, which is liable to drift, and which has only the tops of the ridges occupied by plants. The most abundant are *Leptospermum laevigatum*, var. *minus*, and *Melaleuca parviflora*. Other plants are not prominent; indeed, one or both of these two are often the only plants present. The other species present are *Dodonaea attenuata*, *Acacia ligulata*, *Cassia eremophila*, with locally *Hibbertia crispula* and *Adriana tomentosa*, the lastnamed in hollows. On the bare sand there were occasional plants of *Salsola kali*, *Myriocephalus Stuartii*, and a few tufts of *Stipa*, sp. These scattered tufts appeared dead and were much eaten down by rabbits.

In the Soak the water-table is about 5 ft. to 15 ft. below the surface, but yet this seems to have very little effect on the plants. *Adriana tomentosa*, and possibly *Melaleuca*, are the only species that seem dependent on the presence of ground water. *Adriana*, which is known as the "water bush," has a leaf very different from any other plant found in the district. It is relatively thin and spreading horizontally, neither at all succulent nor hard and coriaceous. The leaves and shoots of this plant have a much smaller water content than most of the other plants found.

Leptospermum, which is such a feature of the sandhills in the basin, also occurs on many of the sandhill ridges in positions quite remote from supplies of bottom water, and it seems better regarded as a plant characteristic of loose sand than of moisture.

Salt Lake.—Separated from the Soak by a high ridge of sand with the typical vegetation of *Acacias*, etc., is another basin occupied by a small salt lake (pl. xxxvi., fig. 1). At the time of our visit this lake was dry, and the loose level soil of the bed was largely composed of soluble crystals, amongst which gypsum crystals were numerous.

The main bed of this lake was bare of plants, but round the margins occurred a halophytic vegetation. That nearest to the bed was an open community of *Arthrocnemum*, spp. (*A. halocnemoides*, *A. halocnemoides*, var. *pergranulatum*, and *Arthrocnemum*, sp.). At a slightly higher level occurred *Frankenia fruticulosa*, often almost pure or mixed with a few plants of *Atriplex paludosum*, *Bassia diacantha*, *Kochia brevifolia*, *Mesembryanthemum aequilaterale*, *Nitraria Schoeberi*, while still higher on the sand just below the typical bushes of the surrounding sandhill flora occurred *Salsola kali*, *Atriplex vesicaria*, *Stipa*, sp. (dead tufts), *Calandrinia volubilis*, and *Didiscus cyanopetalus*. Beyond this zone one passed into the typical sandhill flora (pl. xxxvi., fig. 2).

RELATIONSHIPS OF VEGETATION.

The salt lake just described was interesting, especially as demonstrating the total change of flora that occurs in those parts where the soluble salts in the soil reach a high concentration. None of the species of the "saltbush" or "bluebush" vegetation of the plains, which have so often been termed halophytes by other workers, were present around the lake, with the exception of *Atriplex vesicarium* in small quantities near the extreme margin. The Atriplex of the salt lake was *Atriplex paludosum*, which also occurs in coastal salt swamps; it is a true halophyte. The fact that halophytic vegetation is composed of members of the Chenopodiaceae, and often of species of the same genera that occur on the Nullarbor Plain, cannot be taken as proving that the character plants of the latter habitat are halophytes, as was assumed by Cannon. This distinction between the halophytes of a salt lake and the "saltbush" or "bluebush" communities has previously been noted by Tate *(loc. cit.)*. We regard it as an important one.

In any climate where the evaporation rate is in excess of the precipitation the soil will tend to accumulate considerable quantities of soluble salts. But in no part of the Nullarbor Plain was there any sign of surface accumulation of crystals.

The communities of *Kochia* and *Atriplex* that occupy the surface of the Nullarbor Plain with their rich crop of annuals ought to be regarded as representing a semi-desert flora rather than a halophytic one. The bluebush, and to a less extent the saltbush, seem to represent the succulent flora for this region. Comparisons would be better made between them and the constituents of the succulent communities of South Africa or America than with halophytic plants.

On the Nullarbor Plain the vegetation of the dongas, with the scattered small trees and bushes, represents a further advance that takes place in that area with increasing amounts of soil, and especially of moisture. The communities of the dongas were surprisingly like those developed on the sandhill hollows. They appear to exist under very similar conditions, though the vegetation is much more sparse and less advanced owing to the more severe environmental conditions. Considered in relation to the plain formation as a whole these communities of plants in the dongas appear to represent what Clements(13) would term a post-climax: that is to say, while the general climatic and edaphic conditions cause a stoppage of development on the plain at the stage of an open community of bluebush, in the slightly more favourable conditions in the dongas the process is carried to a further stage. This further development can be traced to some extent; in the smallest depressions only very xerophyllous species occur, *e.g.*, *Acacia tetragonophylla;* larger depressions with more soil have

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(13) Plant Succession, 1916, p. 109.

Acacia aneura, and sometimes *Pittosporum phillyraeoides*; while in the largest, which have most soil, the furthest development occurs, and *Casuarina lepidophloia* forms small scraps of woodland.

The vegetation of the sandhills stands in marked contrast to that of the Nullarbor Plain. Under the same climatic conditions on the sand, even in the most exposed positions, the plant communities are of large woody plants, and the general effect is of some luxuriance. This effect is perhaps more apparent than real, but is certainly marked as compared with the plain. The difference must be attributed to the difference in soil. The loose sand has practically no run-off—all the rain falling percolates into the soil at once. Further, the sand readily forms a quite dry dust mulch on the surface which prevents loss by evaporation, whilst the relatively coarse soil particles carry on a certain amount of condensation. The much finer-grained soil on the plain, on the other hand, will not condense, and, owing to its much greater water-raising power, will lose water by evaporation instead of forming a mulch. As was pointed out above, on the sand we have two distinct sets of communities—those in the hollows and those on the ridges. The former bear a close relation to the communities existing in the dongas, but development proceeds further owing to the better soil and the shelter afforded by the ridges.

Two moderately distinct communities can be recognized, namely, that of *Myoporum platycarpum* and *Heterodendron oleifolium* and the open forest of *Casuarina lepidophloia*. The former occurs where less sand is present. In both cases some developmental stages can be recognized, especially when one compares some of the hollows near the margin of the plain with those further east. The early stages are represented by *Atriplex vesicarium* generally with bushes, especially of *Acacia aneura, A. Randelliana*, and *Eremophila Latrobei*. In the *Myoporum-Heterodendron* phase, which appears as a climax, the *Atriplex* disappears, but the other bushes are still present. When more sand is present the climax appears to be the *Casuarina lepidophloia* forest. It is noticeable that this, rather than the *Myoporum-Heterodendron* community, occupies most of the hollows further east, where the sand has become more distributed. The portions of this forest which have been cut down show a return to the earlier phase with considerable quantities of *Atriplex vesicarium* as undergrowth.

The sandhill ridges, as described earlier, exhibit a series of developmental phases of which mallee *(Eucalyptus)* appears to be the climax. Here again the succession generally reaches a more advanced phase as one passes east for 15 to 20 miles, where mallee is found to cover almost all the sand ridges. On the other hand, nearer the plains, the presumably younger sandhills are almost or quite without mallee and are occupied by Acacias.

To summarize, excluding the salt lake with its highly saline special conditions, one can recognize probably four types of vegetation:—*(a)* The Nullarbor Plain, with its open communities of *Kochia sedifolia* or *Atriplex* spp.; *(b)* the sandhill ridges commencing with *Leptospermum laevigatum* and *Acacia linophylla*, etc., and culminating in an open mallee community; *(c)* the sandhill hollows with sandy soil culminating in open forest of *Casuarina lepidophloia;* and lastly, *(d)* the hollows with firmer soil which appear to reach a climax in the community of *Myoporum platycarpum* and *Heterodendron oleifolium*. These last two are very closely allied and all sorts of transitions with intermediate conditions can be noted.

The donga communities represent attempts stopped by conditions to develop upon the open plain the vegetation characteristic of one or other of these last two types.

FLORA.

A list of the flora so far as we have collected it is given below (Appendix). This has been enlarged by the inclusion of thirty species recorded or collected by Black from the Ooldea district, but not seen by us. The total number of species amounts to 188.

In this list we have given the habitats of the plants dividing the district into six main divisions, *viz.*, the Nullarbor Plain, the dongas on the plain, the sand ridges, the sand flats between the ridges, the Soak, and the salt lake. From such a list the several plant communities recognized by us can easily be seen to have their characteristic floras. Necessarily the classification is somewhat arbitrary, special difficulty being found in deciding whether a plant growing at the edge of the Nullarbor Plain properly belongs to the plain flora or to that of the sandhill areas. Nevertheless, it becomes clear that, as we have stated above, the donga flora has more resemblance to that of the sandhill country than to that of the plain.

Secondly, it will be seen that in the sandhill area the floras of ridges and of flats are strikingly distinct, sufficiently so to recognize them as different associations. Again, however, it has not been possible to distinguish in tabular form between those flats with a deep sandy or loamy soil, and those in which the underlying limestone comes near to the surface. These last are recognized as being inliers of the plain association that have become included in the sandhill area, though in the list they are included as sandhill flats.

Finally, in the list, the plants are classified according to their "life-form," using Raunkiaer's system.(14) As no such examination of an Australian flora has been made before, the ten life-forms recognized by Raunkiaer are briefly defined below.

PHANAEROPHYTES are plants whose dormant buds project freely into the air, *i.e.*, trees and shrubs. They are commonly subdivided according to their height into four groups —

Megaphanaerophytes, tall trees, over 30 m.
Mesophanaerophytes, medium-sized trees, 8-30 m. **MM.**
Microphanaerophytes, small trees and shrubs, 2-8 m. Symbol **M.**
Nanophanaerophytes, shrubs, 2 m. and less. Symbol **N.**

CHAMAEPHYTES (**Ch.**) are plants with buds or shoot apices perennating on the surface of the ground or just above it (under 25 cm.). These buds gain some protection either by snow, or, in dry countries, by dead plant remains.

HEMICRYPTOPHYTES (**H.**) have their dormant buds in the upper soil crust, just below the surface, thereby gaining additional protection. The aerial parts are herbaceous and die away at the onset of the critical period.

CRYPTOPHYTES are plants with their dormant parts well buried in the case of *geophytes* (**G.**), the only subdivision of the class present in the Ooldea flora. Marsh plants *(helophytes)* such as *Typha* and *Phragmites*, and some aquatic plants *(hydrophytes)* as *Nymphaea* and *Potamogeton* form the other subdivision (**HH.**) which is not represented at Ooldea.

THEROPHYTES (**Th.**) are plants the seeds of which germinate rapidly at the favourable season, soon pass into flower and fruit, and then die away. These, therefore, pass the unfavourable season as seeds. They are all annuals, and many in the floras of arid regions are ephemeral. Two other classes are STEM SUCCULENTS, notably scarce in the flora of Australia as a whole, and EPIPHYTES (**E.**). Strictly speaking, these perched plants should gain nothing but an elevated position from the phanaerophytes on which they grow, hence they are best developed in wet regions. No true epiphytes occur at

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(14) Smith, W. G., Raunkiaer's Life-forms and Statistical Methods, Journ. Ecol., i., pp. 16-26, 1913; in this paper the literature is summarized to date. Taylor, W., Growth-forms of the Flora of New York and Vicinity., Am. Journ. Bot., ii., pp. 23-31, 1915.

Ooldea, or indeed in South Australia, but we have placed in this class the many parasites, chiefly *Loranthus*, spp , which are found in the Ooldea florula.

The classification of a flora into these life-forms may be utilized in the following way, as illustrated by the table below (Table III.). For any locality the total number of species analysed is given, followed by the results given as percentages according to the grouping above. "Such an analysis for any region is termed the biological or phyto-climatic spectrum. The normal spectrum is the base line, and the outstanding features of the other spectra are deduced by comparison, not by the highest percentage in their own curve, but by the amount of variation from the normal spectrum. The latter is ideally the phyto-climatic spectrum of the whole earth; actually it is obtained by computation, and at present is given only as approximate. It was arrived at by first selecting 1,000 representative species and then taking 400 of these, which were carefully analysed. This number, 400, has been carefully controlled in various ways," (15) which, however, need not be considered here.

TABLE III.

Biological spectrum of Ooldea district compared with that of other arid regions:—

	Total No. of Species	Percentage of Species belonging to each Life-form									
		MM	**M**	**N**	**Ch**	**H**	**G**	**HH**	**TH**	**E**	**S**
Normal Spectrum	400	6	17	20	9	27	3	1	13	3	1
Ooldea	188	·5	19	**23**	**14**	4	·5	—	**35**	4*	-
Libyan Desert ...	194	—	3	9	**21**	20	4	1	**42**	—	—
Aden	176	—	7	**26**	**27**	19	3	—	17	—	1
Madeira Lowlands	213	—	1	14	7	24	—	3	**51**	—	—
Transcaspian ..	768		10		7	**27**	9	5	**41**	—	--
Death Valley ...	294	—	2	**21**	7	18	2	5	**42**	—	3

* These epiphytes are all parasites, not true epiphytes, see text.

Considering the spectrum of the Ooldea region in relation to the normal, the absence of tall trees,(16) (**MM.**) is as marked a feature as is the smaller number of perennial herbaceous plants, *i.e.*, hemicryptophytes and geophytes. On the other hand, the micro and nanophanerophytes, and also the chamaephytes, are all in excess of the normal percentage. The departure from the normal is most marked in the chamaephytes (5 per cent. increase), but the two Phanaerophyte groups **M.** and **N.** each show 3 per cent. above the normal. This indicates that the environmental factor favours low trees or shrubs. The most marked departure from the normal is in the therophytes. Annuals are a very prominent feature in the Ooldea florula as far as it is known at present, while it is probable that collections made in a "good season" would still further enlarge the class.

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(15) Smith, W. G., *loc. cit.*, p. 18.

(16) *Casuarina lepidophloia*, as found growing at the "Oak forest," was the only tree over 8 metres.

These deviations from the normal become the more interesting when considered in relation to the biologic spectra of other arid regions. Closest correspondence is seen between that of Ooldea and the Death Valley, California. The therophyte percentage of 34 is sufficient to mark the Ooldea region as belonging to the desert series, but the number of low woody plants is exceptional. The micro- and nanophanaerophytes together (**M.** and **N.**) amount to 43 per cent., a number in excess of both the normal spectrum or that of any other arid region available for comparison. Further work on the Australian flora is needed before the significance of this can be fully appreciated. While the Ooldea region may be said to show a therophyte flora, the tendency of its perennials to be woody plants and to have their resting buds above the surface of the ground and not below it (Class **H.** is remarkably subnormal) is certainly a point that calls for further investigation.

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APPENDIX.

The following list contains the complete flora of Ooldea so far as recorded at present. We have distinguished the species recorded by Black and not seen by us by prefixing the letter B., and two species of Acacia are given on Cannon's authority. The six divisions showing the habitat are shown by the following contractions:—Nullarbor Plain, N.P.; Dongas, D.; Sand ridges, S.R.; Sand flats, S.F.; Soak, S.; and Salt Lake, S.L.

		Raunkiaer Class.	N.P.	D.	S.R.	S.F.	S.	S.L.
	Callitris verrucosa, R. Br.	M.			+			
	Triglochin centrocarpa, Hook.	Th.			+			
B.	Panicum gracile, R. Br	H.						
B.	Amphipogon strictus, R. Br., v. gracilis	H.			+	+		
	Stipa setacea, R. Br.	H.	+	+			+	+
	S. scabra, Lindl.	H.	+	+				
B.	S. sclerata, Behr.	H.				+		
	Danthonia penicillata, F. v. M.	H.	+			+		
	Triodia irritans. R. Br.	Ch.			+			

		Raunkaer Class.	N. P.	D.	S. R.	S. F.	S.	S. L.
	Lomandra leucocephala, (R. Br.) Ewart	Ch.			+			
	Thysanotus exiliflorus, F. v. M. . . .	G			+			
	Casuarina lepidophloia, F. v. M. .	MM.		+	+	+		
	Grevillea juncifolia, Hook.	M.			+			
	G. stenobotrya, F. v. M.	M.			+		+	
	G. nematophylla, F. v. M.	M.			+			
	Hakea leucoptera, R. Br. .. .	M.			+		+	
	H. multilineata, Meiss.	M.			+			
	Fusanus acuminatus, R. Br.	M.		+		+		
	F. persicarius, F. v. M.	N.		+		+		
B.	F. spicatus, R. Br.	M.						
	Viscum articulatum, Burm.	E.			+			
	Loranthus exocarpi, Behr.	E.				+		
	L. Preissii, Miq.	E.						
	L. quandang, Lindl.	E.	+	+				
B.	L. miraculosus, Miq.	E.						
B.	L. pendulus, Sieber	E.						
	L. Miquelii, Lehm.	E						
	Rhagodia spinescens, R. Br., var. deltophylla	N.	+			+		
	R. Gaudichaudiana, Moq. .. .	N.				+		
B.	R. Billardierii, Moq.	N.					+	
	R. Preissii, Moq.	N.			+			
	Chenopodium microphyllum, F. v. M., var. desertorum, J. M. B.	N.				+		
	C. nitraraceum, F. v. M.	N.				+		
	Atriplex vesicarium, Hew.	N.	+			+		+
	A. holocarpum, F. v. M.	Th.	+			+		
	A. paludosum, R. Br.	Ch.						+
	A. stipitatum, Benth.	Ch.		+		+		
	A., sp.	Ch.	+					
	Kochia appressa, Benth.	N.	+			+		
	K. brevifolia, R. Br.	N.						+
	K. pyramidata, Benth.	N.	+			+		
	K. sedifolia, F. v. M.	N.	+			+		
	K. triptera, var. erioclada, Benth. ...	N.				+		
	K. aphylla, R. Br.	N.	+					
	Bassia sclerolaenioides, F. v. M.	Ch.	+	+		+		
	B. diacantha, F. v. M.	Ch.	+	+		+		+
	B. echinopsila, F. v. M.	Ch.			+			
	Enchylaena tomentosa, R. Br.	N.					+	
	Arthrocnemum halocnemoides, Nees. ..	N.						+
	A. halocnemoides, var. pergranulatum, J. M. B.	N.						+
	A., sp.	N.						+
	Salsola kali, L., v. strobilifera, Benth.	Th.	+	+		+		
	Trichinium incanum, R. Br.	Th.				+		
B.	T. incanum, v. grandiflorum, Benth. ..	Th.	+					
	T. alopecuroideum, F. v. M.	Th.			+	+		
	T. alopecuroideum, v. rubriflorum, J. M. B.	Th.				+		
	Gyrostemum ramulosus, Desf.	M.			+		+	
	Tetragonia expansa, Murray	Th.	+			+		

		Raunkiaer Class	N. P.	D.	S. R.	S. F.	S.	S. L.
	Mesembryanthemum aequilaterale, Haw.	Ch.						+
	M., sp.	Ch.						+
	Calandrina volubilis, Benth.	Th.		+	+	+		
	C. disperma, J. M. B.	Th.			+			
	C. polyandra, (Hook.) Benth.	Th.	+			+		
B	C. pusilla, Lindl.	Th.						
	Cassytha melantha, R. Br.	E.				+		
	Alyssum minimum, Pallas	Th.				+		
	Stenopetalum lineare, R. Br.	Th.		+	+	+		
	S. sphaerocarpum, F. v. M.	Th.			+	+		
	Lepidium phlebiopetalum, F. v. M.	Th.	+		+	+		
	L. Draba, L.	Th.				+		
	Crassula verticillaris, DC.	Th.			+			
	Pittosporum phillyraeoides, DC.	M.		+		+		
	Acacia colletioides, A. Cunn.	N.				+		
	A. tetragonophylla, F. v. M.	M.	+	+		+		
	A. ligulata, A. Cunn.	N.		+	+	+	+	
	A. Oswaldii, F. v. M.	M.		+		+		
	A. Randelliana, W. V. Fitzg.	M.		+		+		
	A. aneura, F. v. M.	M.	+	+		+		
	A. aneura, v. latifolia, J. M. B.	M.	+	+		+		
	A. linophylla, W. V. Fitzg.	M.			+			
C.	A. brachystachya, Benth.	M.						
C	A. Kempeana, F. v. M.	N.						
	Cassya Sturtii, R. Br.	N.				+		
	C. eremophila, A. Cunn.	N.			+	+	+	
	C. eremophila, v. zygophylla	N.			+	+	+	
	C. eremophila, v. platypoda	N.			+	+	+	
	C. phyllodinia, R. Br.	N.			+	+		
B.	Swainsonia colutoides, F. v. M.	H.						
	Bossiaea Walkeri, F. v. M.	N.			+			
	Lotus australis, Andrews, v. pubescens	Ch.		+				
	Erodium cygnorum, Nees.	Th.		+	+			
	Zygophyllum fruticulosum, DC.	Ch.				+		
	Z. ovatum	Th.	+			+		
	Z. ammophilum, F. v. M.	Th.				+		
	Z., sp.	Th.			+			
	Nitraria Schoeberi, Linn.	N.				+		+
B.	Boronia coerulescens, F. v. M.	Ch.						
	Euphorbia Drummondii, Boiss.	Th.	+			+		
	E. eremophila, A. Cunn.	Th.				+		
	Adriana tomentosa, Gaudich.	N.					+	
B.	Beyeria opaca, F. v. M.	N.						
	Poranthera microphylla, Broug.	Th.			+			
	Stackhousia viminea, Smith.	Th.				+		
	Heterodendron oleifolium, Desf.	M.				+		
	Dodonaea attenuata, A. Cunn.	N.			+	+	+	
	D. microzyga, F. v. M.	N.				+		
	Lavatera plebeja, Sims, var. tomentosa, Hook.	Th.		+				
	Sida corrugata, Lindl.	Ch.	+	+		+		
	S. petrophila, F. v. M.	Ch.				+		

		Raunkiaer Class.	N. P.	D.	S. R.	S. F.	S.	S L.
	Hibbertia crispula, J. M. B.	N.					+	
	Frankenia fruticulosa, DC.	Ch.						+
B.	Lythrum hyssopifolia, L.	Th.						
	Pimelia microcephala, R. Br.	N.			+			
	P. simplex, F. v. M.	Th.		+	+	+		
	Eucalyptus pyriformis, Turcz.	M.			+		+	
	E. leptophylla, Miq.	M.			+			
	E. oleosa, F. v. M.	M.			+			
	E., sp., indet. affin. oleosa	M.			+			
	E. transcontinentalis, J. H. M.	M.			+			
	E. Pimpiniana, J. H. M.	M.			+			
	Leptospermum laevigatum, v. minus, F. v. M.	M.			+		+	
	Melaleuca parviflora, Lindl.	N.					+	
	Didiscus cyanopetalus, F. v. M.	Th.			+			
B.	Alyxia buxifolia, R. Br.	N.			+			
	Convolvulus erubescens, Sims.	Th.		+		+		
B.	Heliotropum europeum, L. :.. . ..	Ch.						
B.	Halgania cyanea, Lindl.	Ch.						
	Echinospermum concavum, F. v. M. ...	Th.	+	+		+		
B.	Dicrastylis beveridgei, F. v. M.	N.						
	Westringia rigidia, R. Br.	N.				+		
B.	W. Dampieri, R. Br.	N.				+		
	Solanum esuriale, Lindl.	Ch.	+					
	S. coactiliferum, J. M. B.	Ch.	+			+		
B.	S. hystrix, R. Br.	Ch.						
	Nicotiana suavoleus, Lehm.	Th.		+				
	Myoporum platycarpum, R. Br.	M.		+		+		
	Eremophila oppositifolia, R. Br.	M.				+		
	E. Latrobii, F. v. M.	M.		+		+		
B.	E. Latrobia, v. Tietkensii, J. M. B. ...	M.						
	E. maculata, F. v. M.	M.						
B.	E. Paisleyi, F. v. M.	M.				+		
B.	E. Goodwini, F. v. M.	M.				+		
	E. glabra, (R. Br.) Ostenf.	M.				+		
	E. alternifolia, R. Br.	M.		+	+	+		
	E. longifolia, F. v. M.	M.		+				
B.	Pholidia scoparia, F. v. M.	M.				+		
	Plantago varia, R. Br.	Th.			+	+		
	Pomax umbellata, Sol.	Th.			+			
B.	Goodenia strophiolata, F. v. M.	Ch.			+	+		
	G. pusilliflora, F. v. M.	Th.	+					
	G. pinnatifida, Schl.	Th.	+	+		+		
B.	Dampiera lanceolata, A. Cunn.	N.			+	+		
	Scaevola spinescens, R. Br.	N.				+		
	Olearia Muelleri, Benth.	N.				+		
	O. subspicata, Benth.	N.				+		
	Minuria leptophylla, DC.	Ch.			+			
	Calotis hispidula, F. v. M.	Th.				+		
B.	C. erinacea, Steetz	Th.			+	+		
	Brachycome pachyptera, F. v. M . .	Th.				+		
	B. ciliaris, Lees.	Th.			+			

		Raunkiaer Class.	N. P.	D.	S. R.	S. F.	S.	S. L.
	Cratystylis conocephala, S. Moore.	N.				+		
	Isoetopsis graminifolia, Turcz.	Th.	+	+		+		
	Myriocephalus rhizocephalus, Benth.	Th.			+			
	M. Stewartii, Wendl.	Th.					+	
	Angianthus tomentosus, Wendl.	Th.		+		+		
	A. pusillus, Benth.	Th.			+			
B.	A. brachyappus, F. v. M.	Th.						
	Gnephosis cyathoppapa, Benth.	Th.	+					
B.	G. skirrophora, Benth.	Th.						
	Podotheca angustifolia, Cass.	Th.			+			
B.	Podolepis capillaris, (Steetz) Diels.	Th.			+	+		
B.	Helichrysum apiculatum, DC.	Ch.			+			
	H. ambiguum, Turcz.	Ch.			+			
	H Lawrencella, F. v. M., v. Davenportii, Benth.	Th.			+			
	H bracteatum, Andr.	Ch.			+			
	H semifertile, F. v. M.	Th.			+			
	Waitzia acuminata, Steetz	Th.			+			
	Helipterum polygalifolium, DC.	Th.		+	+	+		
	H. floribundum, DC.	Th.		+	+	+		
	H roseum, (Hook.) Benth., var. patens, Ewart	Th.			+	+		
	H. hyalospermum, F. v. M.	Th.			+			
	H. strictum, Benth.	Th.			+	+		
	H. pygmeum, Benth.	Th.	+	+	+	+		
	H. moscatum, Benth.	Th.			+			
	H. Humboldtianum, DC.	Th.			+			
	Cephalipterum Drummondii, A. Gray	Th.	+			+		
	Senecio Gregorii, F. v. M.	Th.			+			
	S. brachyglossus, F. v. M.	Th.			+			

DESCRIPTION OF PLATES.

PLATE XXXII.

Fig. 1. General view on Nullarbor Plain showing typical bluebush *(Kochia sedifolia)*. A donga is seen on the left. The trees in the donga are *Acacia aneura*, *Pittosporum phillyraeoides*, and *Fusanus acuminatus*. The soil of the plain shows white limestone fragments, also the flower heads of *Cephalipterum Drummondii*.

Fig. 2. Transition region between plain and sandhill. The trees are not confined entirely to depressions (dongas), though one with a denser tree flora is seen to the left. The main tree is *Acacia aneura*, with occasional *A. tetragonophylla* and *Eremophila Latrobei*, etc. *Atriplex vesicarium* is the chief ground shrub, the soil here being more sandy than on the plain *(cf.* fig. 1). Numerous annuals are present.

PLATE XXXIII.

General birdseye view over sandhill region looking west towards the Nullarbor Plain, which is seen on the horizon, taken from the top of a water tower 30 ft. above the crest of a sand ridge. In foreground sandhill mulga (*A. linophylla*) running to a flat with *Heterodendron*. Another low sand ridge is between this and the plain, where is mulga (*A. aneura*) and some *Casuarina lepidophloia* in dongas, *e.g.*, extreme right.

PLATE XXXIV.

Fig. 1. Typical sand ridge mallee vegetation. The mallees are *Eucalyptus oleosa*, *E. leptophylla*, and *E. transcontinentalis*. The tree in the centre is *Myoporum platycarpum*. Shrubs, *Acacia ligulata, A. Randelliana,* and *Cassia eremophila*. The ground at this season is almost bare. This probably represents the climax on sandhills.

Fig. 2. View in "oak forest," showing old trees of *Casuarina lepidophloia* with some natural regeneration. Bushes of *Acacia Randelliana* and *Fusanus acuminatus*. Ground at this time almost bare; the dead undershrubs appeared to be *Kochia sedifolia*.

PLATE XXXV.

Sandhill flora showing early stages in the succession in the foreground and looking across to mallee on the horizon. The trees in the foreground on either side are *Grevillea stenobotrya*. Below open sandhill succession with *Leptospermum laevigatum*, v. *minus*, *Acacia ligulata,* and *Dodonaea viscosa*, v. *attenuata*. The distant vegetation is mallee of the sandhill climax.

PLATE XXXVI.

Fig. 1. General view over salt lake to mallee-covered hills on horizon. The foreground shows open sandhill succession with *Acacia ligulata* and *Fusanus acuminatus*. The halophytic shrubs of the dry salt lake are seen round the margin and in the bed at the nearer and shallower end. Beyond the lake can be seen the halophytes, some passing into open sandhill flora, behind which is mallee. The branch of the tree in the immediate foreground, left side, is *Grevillea stenobotrya*, and illustrates the leaf habit. The tree is fruiting.

Fig. 2. Salt lake near Soak showing dry bed with no vegetation. *Arthrocnemum*, spp., form a fringe between the bed of the surrounding sandhills on which *Acacia linophylla* and *Fusanus acuminatus* can be seen.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA.
No. 20.

By J. M Black

[Read October 19, 1922]

Plate XXXVII.

Gramineae

Stipa setacea, R. Br, var. **latiglumis,** n. var Variat ligulâ 3-5 mm. longâ, glumis vacuis latis, superiore sub-5-nervi, glumâ floriferâ latâ ad apicem angustatâ et breviter barbatâ, aristâ 25-35 mm. longâ crassiusculâ bis geniculatâ.
Belair ; Minnipa , Telowie Gorge.

S. eremophila, Reader, var. **dodrantaria,** n. var. Variat glumâ floriferâ angustiore, aristâ 6-7 cm. longâ usque ad dodrantem subplumosâ.
Birksgate Range, *R. Helms.*

S. pubescens, R. Br., var. **comosa,** n. var. Variat glumâ floriferâ circiter 4 mm. longâ sericeo-villosâ in comam albam aequilongam desinente.
Marino ; Jamestown ; Melrose ; Moolooloo.

Eriachne ovata, Nees, var. **pedicellata,** n. var. Variat pedicellis capillaribus 5-8 mm. longis, glumâ floriferâ superne villosissimâ sed non ciliatâ glumas vacuas paululum superante.
Musgrave Range, *S. A. White.*

Cyperaceae.

Cyperus exaltatus, Retz., var. **minor,** n. var. Variat umbellâ minore, spiculis 3 mm longis 6-floris.
River Murray.

Scheonus tesquorum, n sp. Perennis, caulibus filiformibus compressis striatis 20-40 cm. altis, foliorum radicalium laminis filiformibus 6-18 cm. longis, bracteis caulinis 2-3 distantibus, earum vaginis 5-20 mm. longis cylindricis fusco-rubris indiscissis, laminis filiformibus 1-4 cm. longis, spiculis fusco-rubris 6-7 mm. longis 2-floris lanceolatis binis usque quaternis in fasciculos terminales et subterminales dispositis, setis hypogynis nullis ; nuce obovoideâ trigonâ albâ.

From between Mount Burr and Mount McIntyre to Nangwarry on the Victorian border. The types are four specimens in the Tate Herbarium, without date or name of collector, but very probably gathered by Professor Tate himself. One of them is marked for transmission to Baron von Mueller, but it appears, from enquiries at the National Herbarium of Victoria, that none was sent. The species stands nearest to *S. apogon*, Roem. et Schult.

IRIDACEAE

***Moraea xerospatha,** MacOwan, var. **monophylla,** n. var. Variat folio radicali semper unico.

In the typical South African form of this little plant, very common in our southern districts, and especially near Adelaide, the number of leaves is given by Baker as 3-4, and by the Kew authorities as 1-4.

CHENOPODIACEAE.

Chenopodium carinatum, R. Br., var. **melanocarpum,** n. var. Variat perianthio fructifero demum nigrescente, ejus segmentis pilosioribus margine contiguis semen tegentibus subacute carinatis. Accedit *Ch. cristato*

Flinders Range, Far North and North-West. Also in Western Australia and at Broken Hill, New South Wales.

Chenopodium microphyllum, F. v. M., var. **desertorum,** n. var. Variat caulibus erectioribus et crassioribus, foliis ovatis vel rhomboideis crassis supra concaviusculis infra dense farinosis 5-12 mm. longis, spicis densius vestitis folia superantibus (10-15 mm. longis), staminibus 5.

Murray lands; Port Augusta westward to Ooldea.

This variety, with thick, often rhomboid, almost papillose leaves and longer spikes, looks very distinct, but some specimens from Baroota, between the Flinders Range and Spencer Gulf, are in some respects almost intermediate between the type and the variety.

Bassia ventricosa, n. sp. Fruticulus ramosus, ramulis albo-tomentosis, foliis lineari-clavatis sessilibus acutis sericeis demum glabrescentibus 5-15 mm. longis, floribus solitariis, perianthii fructiferi tubo parce tomentoso subgloboso 3 mm. diametro ad basin oblongam vix excavato, limbo lanato sat longo, spinis 4 (rarissime 5), quarum duabus 3-5 mm. longis ceteris valde brevioribus unâ nonnunquam adnatâ vel paene obsoletâ omnibus rigidis subdivergentibus plus minusve pilosis, pericarpio superne indurato, semine oblique horizontali.

Port Augusta and Lake Torrens to the Far North; also in the western part of New South Wales. This widely distributed species is easily distinguishable from its allies by its almost globular hairy perianth-tube and its four short unequal slightly divergent spines.

Bassia limbata, n. sp. Fruticulus ramosus tomento denso albo-cinereo paene lanato tectus, foliis lineari-clavatis sessilibus 10-20 mm. longis, floribus solitariis, perianthii fructiferi tubo subcylindrico 3 mm. longo ad apicem 1 mm. lato ad basin oblongam vix excavato cum limbo erecto aequilongo albo-tomentoso, spinis 2 divergentibus rigidis crassiusculis 8-12 mm. longis usque supra medium tomentosis, tertiâ spinâ vel tuberculo minutâ, semine horizontali.

Leigh Creek, Parachilna, Mount Parry (Flinders Range); also near Broken Hill, New South Wales. Allied to *B. bicornis*, (Lindl.) F. v. M., but the latter has a much larger, harder, and more woolly perianth-tube, fiercer spines, less conspicuous limb, and has no third spine or tubercle on the inner face. The basal area of attachment, oblong and scarcely hollowed, in fact only a broad groove, is much the same in both species.

Bassia decurrens, n. sp. Fruticulus suberectus, ramis lanatis denique glabrescentibus, foliis lineari-subteretibus acutis sessilibus parce pilosis 10-15 mm. longis, floribus solitariis, perianthii fructiferi tubo subcompresso glabro vel circum basin lanulato laevi costato-sulcato circ. 3 mm. longo latoque ad basin ovatam paulo excavato, spinis 2 glabris divergentibus basin versus dilatatis 6-8 mm. longis, quarum una in 3 spinas brevissimas vel tubercula decurrit, limbo tubum aequante ad apicem truncato et ciliato, semine verticali.

Near Port Augusta; also in western New South Wales. Differs from the other species with vertical seeds in its smooth ribbed glabrous perianth-tube, with two broad-based divergent spines of which one terminates at the base in three very short spines or tubercles, while the base of the tube is ovate or almost orbicular and only slightly oblique and hollowed on the inner face.

Bassia paradoxa, (R. Br.) F. v. M., var. **latifolia,** n. var. Variat foliis 15-25 mm. longis 5-8 mm. latis dense tomentosis, capitulis 15 mm. diametro, spinis (in paucis speciminibus quae adsunt) ad 5 cornua brevia obtusa reductis.

Strzelecki Creek, *S. A. White*. The five short obtuse and rather soft horns are very different from the usually sharp rigid spines of typical *B. paradoxa*, but it is certain that considerable variation exists in the length and texture of the

dorsal appendages even in specimens which are otherwise typical. The new variety can be at once distinguished by its very broad thick and soft leaves. My specimens are too few to ensure certainty as to the appendages being constantly of the form described.

In dealing with the *Bassias*, I have had the advantage of consultation with Mr. J. H. Maiden, Government Botanist, and Mr. R. H. Anderson, botanical assistant at the National Herbarium, Sydney. Mr. Anderson is engaged on a much-needed revision of the Australian *Bassias*.

Atriplex leptocarpum, F. v. M., var. **acuminatum,** n. var. Foliis obovatis plerisque sinuato-dentatis; bracteolis fructiferis 5-8 mm. longis, lobis (partibus liberis) acuminatis tubo indurato fere aequilongis nonnunquam in utroque margine minute unidentato et saepe ad basin 2 parvis tuberculis dorsalibus instructis.

Tarcoola, Ooldea.

Babbagia acroptera, F. v. M., et Tate, var. **deminuta,** n. var. Variat grandiore alâ crassâ rubellâ oblongo-incurvâ vix 2 mm. longâ, alterâ minimâ vel fere obsoletâ.

West of Port Augusta.

Kochia scleroptera, n. sp. Fruticulus suberectus, ramis albo-tomentosis, foliis linearibus acutis sericeo-villosis 6-12 mm. longis nervo medio saepe conspicuo infra, floralibus saepe caducis, floribus in longas spicas confertis, perianthio fructifero valde depresso sub tomento dense lanato obtecto 4-5 mm. diametro 5 alis brevibus obtusis rigidis crassiusculis horizontalibus comprehensis, tubo brevissime convexo vix 1 mm. longo 2 mm. lato infra alas ipsas.

Arkaringa and Alberga Creeks. This species is only known by two specimens collected by R. Helms on the Elder Expedition in 1891, and one obtained by Miss Staer in 1913 at Todmorden Station, on the Alberga. Like *K. brevifolia* it has five distinct equal horizontal wings without appendages, but differs entirely in the thickness and rigidity of the wings and in their dense woolly clothing. The perianth bears some resemblance to that of *K. lanosa* or of *Bassia sclerolaenoides*.

UMBELLIFERAE.

Uldinia, n. gen. Floribus paucis breviter pedicellatis in umbellam simplicem pedunculatam conjunctis, calycis dentibus obsoletis, petalis ovatis obtusis leviter imbricatis, stylis brevibus, fructu ovato a latere valde compresso basi emarginato mox bipartibili, mericarpiis 5-jugis, jugo dorsali aculeis uncinatis divaricatis biserialibus marginato, jugis intermediis prominulis medianis parcius aculeatis, utroque jugo intermedio in alam divaricatam lanceolatam uncinato-ciliolatam 3-5 mm. longam ad apicem desinente (alis eas pedium Mercurii simulantibus), jugis marginalibus prominulis, vittis nullis, carpophoro obsolescente setaceo uno mericarpio adnato et cum eo deciduo, foliis palmatipartitis petiolatis, petiolo basin versus subdilatato pilis longis ciliato ad basin ipsam fimbriato sed non rite stipulato

Uldinia mercurialis n. sp (Tab. xxxvii.). Herba annua, caulibus prostratis rigidis plerisque simplicibus glabris, foliis radicalibus longe petiolatis, laminâ ambitu suborbiculari-cordatâ 10-15 mm longâ parcissime pilosâ tripartitâ, segmentis ovato-cuneatis obtuse trifidis vel lobato-incisis, petiolo 10-30 mm. longo, foliis caulinis valde minoribus plerisque oppositis, umbellis 4-floris, pedunculis robustis 5-7 mm longis axillaribus, petalis caeruleis 1 mm. longis, involucri bracteis 4 lanceolatis ciliatis circiter 3 mm. longis, mericarpiis minute papillosis 4 mm. longis vix 2 mm. latis minus quam 1 mm. crassis, alis divaricatis 2-4 mm. longis.

This curious little plant, collected by Mr. E. H. Ising along the railway line at Ooldea in September, 1920, does not seem to fit into any of the existing genera of the tribe *Hydrocotyleae*. It has the habit of *Didiscus*, but differs in the absence of a free persistent carpophore. In the somewhat dilated and ciliate base of the petiole it resembles *D. glaucifolius*. The carpophore of *Uldinia* is setaceous and adnate to the slightly grooved face of the narrow commissure of one of the two mericarps. It is fragile at base and falls off with the mericarp to which it is attached. From *Hydrocotyle* it differs in the deeply-cut leaves, the absence of stipules, the imbricate petals, and the dry station, from *Trachymene*, DC., in the absence of a free persistent carpophore, in the petals not inflexed, in the simple umbels and the dilated base of the petiole: from *Centella* in the lesser number of ribs on the mericarp and the divided leavps. As regards the two new Australian genera created by Domin in 1908 (in Beihefte zum Botan. Centralblatt, xxiii., Abt. ii., 291-4), it differs from *Neosciadium* in the flattened fruit, deeply-cut leaves, and in the absence of free stipules. (*N. glochidiatum*, Dom. = *Hydrocotyle glochidiata*, Benth.; *Centella glochidiata*, Drude.) From the other new genus, *Homalosciadium*, it differs in the adnate deciduous carpophore, and from both of these genera in the few-flowered umbels. (*H. verticillatum*, Dom. = *Hydrocotyle verticillata*, Turcz.; *Centella homalocarpa*, Drude.) The hooked prickles or bristles which stand

in two rows along the narrow keel or dorsal rib of the mericarp and are scattered along the intermediate ribs, differ markedly from those of *Neosciadium*, where they consist of straight slender bristles with several short reflexed barbs or hairs near the summit, whereas in *Uldinia* they are simple, stout, and hooked at the end. Still more remarkable are the two lanceolate wings attached to the summit of each intermediate rib and spreading outwards at right angles to the flattened sides of the mericarp. By their shape and position they recall the wings with which classic legend adorned the feet of Mercury. As far as my knowledge goes, they do not occur in any other umbelliferous plant. They also have small hooked prickles along the margin, so that the fruit appears well adapted for transport either by animals or by the wind. The divaricate wings and the hooked prickles should perhaps be ranked rather as specific than generic characters, but even in that case the other peculiarities of the plant appear sufficient to necessitate the creation of a new, although probably monotypic genus.

The name of the new genus is derived from "ûldilnga gabi," the native name of "Ooldea Water," more generally known as the Ooldea Soak, and about three miles from the Ooldea Railway Station.

MYOPORACEAE

Eremophila pentaptera, n. sp. (Tab. xxxvii.) Frutex humillimus glaber circ. 30 cm. altus, caulibus erectis, foliis alternis crassis subplanis oblongo-cuneatis sessilibus obtusissimus 10-35 mm. longis 4-8 mm. latis, floribus solitariis subsessilibus, pedunculis brevissimis erectis obconicis acute quinquangulis circ. 5 mm. longis, calycis segmentis aequalibus circ. 12 mm. longis glabris lanceolato-acuminatus sed obtusis valde imbricatis secus dorsum acute carinatis vel anguste alatis in pedunculum brevem decurrentibus, corollâ violaceâ 25-35 mm. longâ exterius glabrâ in faucibus albâ lanatâ maculis fulvis obsitâ, tubo ad basin cylindrico sursum sensim dilatato, omnibus lobis rotundatis et tubo aequilongis (exceptis 2 supremis brevioribus) infimo truncato 14-18 mm. lato, staminibus inclusis, ovario conico glabro, stylo pilosulo, ovulis 2 in utroque loculo, fructu non viso.

This lowly Eremophila was discovered by Professor F. Wood Jones in September, 1922, on flats near Miller Creek, about 60 miles (100 km.) north-east of Kingoonya Railway Station. It appears to be local in its distribution. The ovary has two cells, each with two ovules, and the corolla-tube has a cylindrical base, in which respect it agrees chiefly with

Pholidia, but the size and shape of the upper part of the corolla and the large thick leaves belong rather to *Eremophila*. In any case, the desirability of uniting the two genera seems now to be generally conceded. In the broad, fleshy, rather large, and very obtuse leaves, and the sharply-keeled or narrowly-winged calyx-segments, which run down into an acutely 5-angled peduncle so short that it appeared to be merely the contracted base of the calyx, the new species is well distinguished.

DESCRIPTION OF PLATE XXXVII.

1. *Eremophila pentaptera*, n sp *A*, branch. *B*, corolla spread open. *C*, 5-angled peduncle and pistil, *D*, vertical section of ovary. *E*, calyx and peduncle.

2 *Uldinia mercurialis*, n. sp. *F*, radical leaf *G*, upper part of stem *H* mericarp. *I*, transverse section of fruit.

TYPES OF SPECIES OF AUSTRALASIAN POLYPLACOPHORA DESCRIBED BY DE BLAINVILLE, LAMARCK, DE ROCHBRUNE, AND OTHERS, NOW IN THE MUSEUM D'HISTOIRE NATURELLE, IN PARIS.

By EDWIN ASHBY, F.L.S., M.B O.U

[Read October 19, 1922.]

The following is a *resumé* of the results of an examination recently made by the writer of the collections of Australasian *Polyplacophora* under the care of the Laboratoire de Malacologie Rue de Buffon, Paris.

The writer's warmest thanks are due to Professor Joubin for permission to examine the collections, and to Dr. Ed. Lamy, for not only placing the extensive collections at his disposal, but also for much help in the identification of the specimens from which Blainville and other writers made their original descriptions.

In offering the within notes on these collections, the writer is conscious of limitations due to the shortness of the time at his disposal entirely precluding the possibility of checking through his rough notes before transcribing them.

The fortunate rediscovery of some of the lost types, notably of Blainville and Lamarck, on which so much has been written by Dr. Pilsbry, Mr. Tom Iredale, and others, will, I feel sure, be appreciated by all workers.

Fairly full notes have been given of a good deal of material of less importance than the types before referred to. This has been done because the writer had an unique opportunity of comparing the specimens with those of his own collection which he brought to Europe for this purpose, and which is undoubtedly the most complete collection of Australian chitons that has up to the present been made. The references given are not complete, but sufficiently so for the purposes of this paper. As far as possible the notes have been arranged in the order of modern classification.

Callochiton dentatus, Spengl., Australe One specimen on card. On the back is marked "*fulgetrum*, Reeve." It is very worn, but I have no doubt it is *C. platessa*, Gould.

Lepidopleurus fodiatus, Rochebr. Type (Bull. Soc. Philom., 1880-81, p. 120). The card on which these shells are mounted is marked "*Is.* (*Radsella*) *fodiatus*, Rochebr." Also, there are several separate valves in spirit marked on label "*Is. tigrinus*, Kraus." Other notes on the label, "New Holland, M. Verreaux, 1842 Type, M^3 108."

This shell has very large scales grooved with very fine striae. Lateral area 11 radial ribs, median areas covered with flattened, wavy ribs which are so extremely bridged as to approximate to the sculpture of a *Callistochiton*.

I have never seen this shell in Australia and am confident the locality given is incorrect.

Stenochiton (Chiton) longicymba, Blainville. Type (Dict. Sc. Nat., xxxvi., 1825); *Stenochiton juloides*, Ad. and Ang.; *Schizochiton nympha*, Rochebr., non *Chiton longicymba*, Bl., of Quoy et Gaimard.

The full particulars of the steps that led to the identification of Rochebrune's type of *Schizochiton nympha* with Blainville's lost type of *C. longicymba* are fully given in a paper by the writer which is being published by the Malacological Society, London.

Ischnochiton (Chiton) lineolatus, Blainville. Type (Dict. Sc. Nat., vol. xxxvi., p. 541, 1825). See "Review of *Chiton crispus*, Reeve, by Ashby (Trans. Roy. Soc. S. Austr., vol. xliv., 1920, pp. 272-275); non *lineolatus*, Blain., of Iredale and May; *haddoni*, of Pilsbry; *I. crispus*, Reeve, of Bednall, Torr. In my paper (*l.c.*) I recognized Blainville's *Chiton lineolatus* in the shell we had known as *I. crispus*, Reeve, common to South Australia, Victoria, and Tasmania; and later, I received from Major Paul Dupuis, of Brussels, cotypes of Blainville's *lineolatus*, collected by Peron et Lesueur in King Island, one of the specimens being marked inside "Ile King." This confirmed my previous conclusions. Of the two specimens mounted on the card marked "Type Peron et Lesueur, Ile King," the larger shell is smooth and shiny, has no radial ribbing, but shows near the insertion plates, broken, shallow, concentric ribbing. The dorsal area is almost smooth and polished, the fine decussation, although present, is inconspicuous. The lateral and median areas are much less coarse in sculpture than is the case with *Ischnochiton iredalei*, Dupuis, which is the shell that Iredale had concluded was Blainville's *lineolatus*; the jugum in the type is not so rounded as in the latter species, but shows a fairly sharp angle and also a single flame mark bordering the dorsal area. Except the flame mark the type corresponds with the shell given me by Major Dupuis before referred to. In the second and smaller specimen on the card, the radial ribbing is present on the anterior and posterior valves and in the lateral areas of the median valves; altogether the sculpture is much stronger than is the case with the larger specimen. While this sculpture approaches *I. iredalei*, Dupuis, the marked jugal ridge separates it from that species, and the sculpture of this area is less strong than on that species. The girdle, while showing stains, is certainly a pale girdle.

There are on three other cards marked "Peron et Lesueur, Ile King," one, two, and three specimens, respectively. In all the sculpture is coarser than is the case with the larger one on the card marked "type." While it is possible that some of them may be juvenile specimens of *Heterozona sub-viridis*, Ire. and May, I could not distinguish any pointed large scales that are so characteristic of that species.

In conclusion.—This investigation determines the facts that (1) Iredale was wrong in identifying the shell we used to know as *Ischnochiton contractus*, Rv., and now known as *I. iredalei*, Dup., with Blainville's *Chiton lineolatus*. (2) The larger specimen on the type card, which I accept as the type, is undoubtedly the shell we used to know as *I crispus*, Rv. (3) While it is possible that some of the specimens brought from King Island by Peron and Lesueur, and mounted on the separate cards may be juvenile forms of *H. sub-viridis*, Ire. and May, their present condition makes accurate determination difficult.

Ischnochiton (Lepidopleurus) campbelli, Filhol. Type (Comptes Rendus, xci., p. 1095, 1880). Iredale in Trans. N. Z'd Inst., vol. xlvii., 1914, p. 419. The type is from Campbell Island and is a half-grown specimen similar to one of the same size in my own collection.

Ischnochiton melanterus, Rochebrune. Type (Bull. Soc. Philom., Paris, 1883-84, p. 137), from Campbell Island. This is conspecific with the preceding species.

Ischnochiton (Chiton) tessellatus, Quoy et Gaimard. Type (Voy. de l'Astrol. Zool., iii., p. 396; Atlas, t. 75, f. 43-47). This specimen is mounted on a card and marked "Il des Kangaroo," but in Pilsbry the locality is given Port Carteret, New Ireland. On the back of the card there is the note, "*C. cymbium*, Dufrizai. M.S.S." This shell has girdle scales that are large, bead-like, polished, and almost smooth at apex; elsewhere very finely striated. Anterior and posterior valves and lateral areas of median valves show strong, slightly broken, radial ribs 5 or 6 in number. The median areas closely packed with narrow, well-defined, wavy, longitudinal ribs, curiously pectinated. I have never seen this shell in Australia.

Ischnochiton (Chiton) sulcatus, Quoy et Gaimard. Type (Voy. de l'Astrol., iii., p. 385, t. 75, f. 31-36). The card is marked "*Gymnoplax urvillei*, Rochebrune"; also "M. M., Quoy et Gaimard. Type, from Port du Roi George." It is a strongly-marked specimen of the shell we now know as

I. contractus, Rv. The synonymy is given by Iredale and May (Proc. Mal. Soc., vol. xii., pts. ii. and iii., Nov., 1916) as follows:—*I. contractus*, Rv., 1847; *C. sulcatus*, Quoy et Gaim., 1834, non Wood, 1815; *C. decussatus*, Rv., 1847, *C. castus*, Rv., 1847; *Lepidopleurus speciosus*, Ad. and Ang., 1864; *Gymnoplax urvillei*, Rochebr., 1881.

Plaxiphora (Chiton) biramosa, Quoy et Gaim., 1833. Type, New Zealand (Voy. de l'Astrol., iii., p 378, pl. 74, figs. 12-16). This specimen is very badly eroded, showing no sculpture, only a few zebra-like markings on a brown ground.

Plaxiphora (Chiton albidus) albida, Blainville. Type, Ile King (Dict. Sc Nat., vol. xxxvi., p. 547, 1825). There are six valves in tube marked type, M_3 36a, anterior, posterior, and four median valves. These were disarticulated by Dr. J. Thiele, and, as stated by him, are very bleached and eroded, but one of the valves shows distinct wrinkling, and all show, near margins, growth-lines and the usual, although faded, green and brown dashes or bands.

Plaxiphora (Chiton costatus) costata, Blainville. Type, Port du Roi George (Dict. Sc. Nat., vol. xxxvi., p. 548). The specimens, which are dissected, are also labelled "*Chaetopleura costata*, Bl." This is the usual ribbed and wrinkled form of *Plaxiphora* found in South Australia. The anterior diagonal rib is well defined and a large portion of it smooth, the posterior margin of the median valves is not well defined The wrinkling is very marked in zigzags. The usual green colour markings are present.

Plaxiphora (Chiton glaucus) glauca, Quoy et Gaim. Type, Van Diemen (Voy. de l'Astrol. Zool., iii., p. 376, t. 74, f 7-11, 1834); marked in (Quoy or Gaimard's) handwriting as from Van Diemen. There are only four valves, which belong to the smooth form, without wrinkles. I have similar specimens from Tasmania. The shell is a good deal eroded, but there is sufficient to show that, when perfect, it was unwrinkled.

Comment.—Dr. Thiele quite correctly recognized de Blainville's *C. costatus* in the wrinkled form of *Plaxiphora*, ranging from Victoria to Western Australia, which appears to have been described by Sowerby under the name of *P. petholata*. But he concluded that the bleached and eroded specimen described by Blainville under the name of *C. albidus* must be the smooth form described by Quoy et Gaim. under the name of *C. glaucus*. The discovery of defined wrinkling on one of the valves of Blainville's type of *C. albidus* disproves this. I am satisfied that his *albidus* and *costatus* are conspecific, the former being a worn and bleached specimen of the latter. As *albidus* has page priority, it must stand as the name of the wrinkled shell, and *Plaxiphora costata*, Bl., as a synonym thereof. Whether the whole of the forms of *Plaxiphora* found in Southern and Western Australia are all referable to one very variable species or not, must be left to future investigation. For the present I purpose to include all wrinkled forms from Victoria and Tasmania and westward under the name of *P. albida*, Bl., with *P. conspersa*, Ad. and Ang., as a subspecific name for the extremely sculptured form which has its headquarters at Port Lincoln. The unwrinkled forms I would refer to *P. glauca*, Quoy et Gaim., of which the type is from Tasmania.

Plaxiphora varipilosa, Blainville. Type (no locality). This is a disarticulated specimen showing no sculpture and is very smooth and polished. More rounded (except near the beak, which is raised) than is the case with Australian representatives of this genus. It is decorated with longitudinal brown streaks, but has none of the typical markings that are so characteristic of Australian specimens; it is evidently not an Australian shell.

Cryptoplax montanoi, Rochebrune. Type, in spirit, Is. Soulon, Drs. Montano et Ray (Pilsbry gives locality as Leucon, Borneo), No. 74, 1880 (Bull. Soc. Philom., Paris, 1881-82, p. 1901), is marked "*C. oculatus*, Q. et G." This specimen is well preserved in spirit and is conspecific with a specimen in my own collection which is also marked "*C. oculatus*, Q. et G.," and is from I. Sula. Both these differ from specimens marked "*C. larvaeformis*, (Blain.)' Burrow, 1815,'' in that the first three valves are circular and not oval, as is the case in the latter. In all other respects they seem alike. We were not able to find the type of *C. oculatus*, Quoy et Gaim., so cannot say whether these two are conspecific

Cryptoplax (cryptoconchus) larvaeformis, (Blain.) Burrow (Elem. of Conch., pp. 190, 191, t. 28, f. 2, 3, 4, 1915). I saw a card with old label, "I. O. Lisse. *Ch laevis*, Lam. Habite les Mers de la Novelle-Holland,'' determined later as *C. larvaeformis*, Burrow. This specimen is similar to others in the same collection from New Caledonia and Tonga Tabu. I have noted that all these resemble my shell and Rochebrune's *montanoi*, except that in them valves 1 and 2 only are round oval, whereas in the latter the three first valves are almost circular. The girdle spicules of all are very similar.

Cryptoplax lamarcki, Rochebrune, from New Caledonia, marked "co-type." This specimen appears to correspond with *C. larvaeformis*, Burrow, in that the anterior valve is oval and not circular, as in *mondanoi*, Rochebr.

Cryptoplax torresianus, Rochebrune. Type (Bull. Soc. Philom., Paris, 1881-82, p. 195, 1881). The following are copied from Rochebrune's MS. notes.—"*Chitonellus striatus* (Rv., C. Icon., pl 1, sp 4), long. O. 060, lat. O. 004, M.M., non *C. striatus*, Lam Hab., detroit de Torres. Mus . Paris" I compared this type with my shell from Sydney and found them conspecific; my largest specimen is a counterpart of the type, which is numbered N. 13, 8.

Cryptoplax (Chitonellus) laevis, Lamarck. Type (de Lamarck animaux sans vertebres, vol. 7, Mollusques). Lab. de Malacologie, K. 82 Oscabrelle lisse, De Blainville, Malac., pl 87, f. 5. Hab. les Mers de la Novelle-Hollandiae. Peron et Lesueur I saw type marked as such in Rochebrune's handwriting The same specimen is marked "type of *Cryptoplax (Chitonellus) lamarcki*, Rochebr.," and the card is marked "Peron et Lesueur, N. 1^5 3," and agrees with figure, pl. 87, fig. 5, Blain., Manu. de Malacologie. This type shell measures 49 × 12 mm , and, as just stated, corresponds with the figure Nearly the whole of the shell is eroded and the girdle is denuded of spicules, except on that portion commencing opposite valve 7, where the spicules are fortunately still in evidence. These spicules are very peculiar, being very widely spaced, short, blunt and rounded, quite distinct from any species I have seen from either the south or the east coast of Australia; neither does it agree with the specimen of *Cryptoplax* I collected at Rottnest, in Western Australia. On the other hand, the small specimen I collected at Yallingup, in that State, in October, 1920, and provisionally referred to as *C. hartmeyeri*, Thiele—see my paper (Trans. Roy. Soc. S. Austr., vol. xlv., 1921)—may be a juvenile of this species. Should this identification ultimately prove correct, *C. hartmeyeri*, Thiele (the type of which I have never seen), will probably be proved to be conspecific, and name will be a synonym of *C. laevis*, Lam.

Cryptoplax (Chitonellus) striatus, Lamarck. Type (An. S. Vert., vi., p. 317, 1819). The type specimen is marked in Lamarck's handwriting, "Oscabrelle striée, *Chitonellus striatus*. Ile aux Kangaroo." The type measures 46 × 10 mm.; valves 5, 6, and 7 would be slightly spaced if the specimen had been carefully dried. The sculpture is similar to the common South Australian shell, and although very few spicules are left on the girdle, those that remain correspond with the South Australian species, which is quite natural, as Kangaroo Island, in that State, is the type locality.

Comments.—The rediscovery of Lamarck's two lost types is due to the very careful search made by Dr. Lamy. I was told on arrival that these types were not in the Museum in

Paris, and were probably in Geneva. But on calling attention to the reference in the original description to their deposition in Paris, Dr. Lamy turned up Rochebrune's MS and found that when those notes were written Lamarck's types were still in Paris. A further search was at last rewarded with their recovery. Pilsbry's figures in pls. 9 and 11, Man. Con., vol. xv., are, I have no doubt, drawn from New South Wales specimens I agree with Mr. Tom Iredale that these northern shells are a distinct species, and not Lamarck's *striatus*. As a result of the foregoing investigation we are able to recognize:—

(1) *Cryptoplax laevis*, Lamarck = *C. lamarcki*, Rochebr; probably = *C. hartmeyeri*, Thiele, and is only known for Western Australia.

(2) *Cryptoplax striatus*, Lamarck, found in Victoria, Tasmania, South Australia, and Western Australia.

(3) *Cryptoplax torresianus*, Rochebrune. Found from Port Jackson northwards to Torres Straits.

(4) *Cryptoplax gunni*, Reeve. Occurring in South Australia and having probably a range of habitat coextensive with *C. striatus*, Lam., from which species it is easily distinguished by its dense, very short, and slender spicules.

Three further species are all said to occur in Australian waters:—*C. oculatus*, Quoy et Gaim.; *C. burrowi*, Smith; *C. .michaelseni*, Thiele. The two first in the tropical waters of Queensland, and the latter in Shark Bay, Western Australia.

Acanthochiton sueurii, Blanville. Type (Dict. Sc. Nat., xxxvi., p. 553, Blainville). There are two specimens with original label "Port Roi George." They are undoubtedly the shell we have known as *Acanthochiton asbestoides*, Smith. The better of the two is similar to a pale specimen I collected at Port Lincoln, in South Australia.

Acanthochiton jacundus, Rochebrune. Type (Bull. Soc. Philom., 1881-82, p. 194). There are a number of specimens in spirit which are conspecific with preceding species, all much worn.

Acanthochiton violaceus, Quoy et Gaim Type (Voy. de l'Astrol., iii., p. 403, t. 73, f. 15-20), New Zealand. These are similar to specimens in my own collection from Doubtless Bay, New Zealand.

Acanthochiton violaceus, var. *papillo*. Type. On another card marked "Quoy et Gaimard, 1883, N.Z.," is a dissected specimen with anterior valve missing. All valves smooth and of peculiar shape. I am rather doubtful whether this is referable to the same species. It is referred to in Voy. de l'Astrolabe at top of page 520 under the name *papillo*.

Cryptoconchus (Acanthochites) monticularis, Quoy et Gaim. Type from New Zealand (Voy. de l'Astrol , p. 106, t. 73, f. 30-35, 1834). This is undoubtedly conspecific with *Cryptoconchus porosus*, Burrow (Elem. Conch., p. 189, t 28, f. 1, 1815).

Cryptoconchus stewartianus, Rochebrune Type (Bull. Soc. Philom , Paris, p. 194, 1881-82). Type is in spirit and is evidently conspecific with preceding species.

Acanthochiton zelandicus, Quoy et Gaimard. Type, in spirit (Zool. Voy. de l'Astrol., iii., p. 400, t. 73, f 5-8, 1834), marked on label "M. Quoy et Gaimard, 1833." The shell is decorated with flat, rounded pustules. The dorsal area is partly smooth, but the rest of the area shows longitudinal striae. They are similar to shells in my own collection from Auckland Harbour.

Acanthochiton (Loboplax) stewartiana, Thiele. Type is in spirit and marked "Collected by Filhol, Ile Stewart." The following are my notes:—Anterior valve decorated with five well-raised rays formed of largish, elongate, flat pustules. Median valves with a diagonal fold and decorated with rows of diagonally-placed, raised, oval, flat pustules; much like *A. granostriatus*, Pilsbry. The posterior valve is very distinct, dorsal area pinnatifid, in the front of mucro pustules are similar in character to those of the median valves. Mucro raised, posterior and distinct. Area behind mucro flat to concave. A small specimen in my collection, from Wellington, is similar in sculpture but has not the strong rays in the anterior valve.

Note.—Several other *Acanthochitons* in the collection in Paris will be dealt with later.

Rhyssoplax (Chiton) canaliculatus, Quoy et Gaimard. Type (Voy. de l'Astrol. Zool., iii , p. 394; Atlas, t. 75, f. 37-42, 1834), marked "Voy. Astrol., 1829, New Zealand." There are no scales left on girdle of type. The sculpture is similar to specimens so named in my collection.

Sypharochiton (Chiton) pellis-serpentis, Quoy et Gaimard. Type, in spirit (Voy. de l'Astrol. Zool iii., Moll., p. 381, t. 741, f. 17-22, 1834); label in handwriting of de Blainville reads, "Oscabricon a Serpent, pl. 741, fig. 17-22, New Zealand, Astrolobe." There are three specimens of this well-known shell. In all there is very little sculpture in the median areas, but the lateral areas are quite normal. One of the three is quite as carinated as *S. sinclairi*, Gray.

Liolophura (Chiton) hirtosus, (Peron MS.) Blainville. Type (Dict. Sci. Nat., xxxvi., p. 546, 1826), Dr. J. Thiele (Fauna S.W. Austr , p. 399, 1911), Dupuis (Ex. Bull Mus.

Hist. Nat., 1917, No 7, p. 1, 2), and *l.c.*, p 7, 1918 These latter point out that in the Paris Museum are two specimens collected by Peron; the one marked type, which I call *(a)*, is conspecific with *Liolophura (Chiton) georgiana*, Quoy et Gaim. The other, which I call *(b)*, is marked co-type, was identified by Dr. Thiele as conspecific with *Acanthopleura spiniger*, Sow. The following are my notes on the type specimen, which is disarticulated. The card is marked "*Chiton hirtosus*, Peron = *Chiton georgianus*, Quoy et Gaimard, Ile King"; and has labels at the back which read, "See pg. 533, Bull. du Mus. d'Histoire Nat. (in Blainville's handwriting), *hirtosus*, Bl."; in Peron's handwriting, "*hirtosus*, Ile King", and in Quoy or Gaimard's handwriting, "*Aculiatum*."

The large median valve measures laterally 30 mm. The sculpture is almost entirely eroded, broken and beaded growth-lines are slightly visible in the lateral areas, and what little sculpture remains on the rest of the valve consists of concentric ridges. The anterior valve is slit and propped, but the insertion plate is absent or modified in the manner characteristic of *L. georgiana*, Quoy et Gaim.; the girdle scales are also similar to that species. There is a note on the back of the card, "Dr. Thiele det. this is undoubtedly Quoy et Gaimard's shell." In this determination I fully concur. I have no doubt the specimen came from Port du Roi George, and not from Ile King, as marked on card; but until a careful search for *Chitons* be made on that island, the locality from which the type came must remain an open question.

Specimen *(b)*.

The card is marked "Co-type, *Chiton hirtosus*, (Peron) Blainville. M. M. Peron et Lesueur, 1803, I. King, M^{r} 886 = *Acanthopleura spinigera*, Sow." On back it has the following notes, "Ile King, *Chiton hirtosus*, Peron, 233," in Peron's handwriting; two words that look like "Leplus grand, *A. aculeata*, L., I King," in Lamarck's handwriting, and "*Acanthopleura spinigera*, Sow., Thiele det." This specimen is similar in sculpture and spicules to specimens in my collection from Port Darwin which I have considered are referable to Blainville's *Chiton gemmata* The shell is a good deal curled but is in good preservation and measures 51 × 38 mm. This could not have come from Ile King, but possibly Baudin sailed north as far as Shark Bay, where this *Acanthopleura* occurs. Is it not possible that this is the missing type of Blainville's *Chiton gemmatus?* Up to the present I have not been able to refer to the original description of that species.

Specimen *(c)*.

On another card is a specimen, which I am calling *(c)*, marked "*Liolophura hirtosa*, Peron: collected by Peron et Lesueur, 1803." In Dr Lamy's opinion this specimen is the black variety described by Blainville, 1825, as variety V of his *Chiton gemmatus*. The shell shows very little sculpture, the dorsal area is eroded, but the rest of the shell is well preserved There are very deep growth-lines and ridges, which are only subpustulose in the lateral areas. It is curled and measures 30 × 23 mm. This spm. = *Liolophura hirtosa*, (Peron) Blainville.

Note —Blainville states that his variety V was in the collection of the Paris Museum, but that the type of normal *C. gemmatus* was in his own collection

Specimen card

This has two specimens mounted on it; they are marked "*L. georgiana*, Q. et G., Port du Roi George." These are not that species, but are the Sydney shell *L. gaimardi*, Blainville. There are sufficient of the girdle spicules left to assure the correctness of the determination.

Specimen *(e)*.

This is in spirit and marked "*Acanthopleura quatrefagesi*, Rochebrune (Rochebr., Bull. Soc. Philom., 1880-81, p. 117; Jour. de Conch., 1881, p. 44)." This is *Liolophura hirtosa*, (Peron) Blainville, and very probably was one of Blainville's original shells.

Liolophura (Chiton) georgiana, Quoy et Gaimard. Type (Voy. de l'Astrol. Zool., iii., p. 379, t. 75, f. 25-30, 1833), Port du Roi George. There are four specimens quite typical of this common Western Australian shell; as Peron's name, *hirtosus*, was published by Blainville in 1825, that name replaces that of Quoy et Gaimard. There are old labels attached reading, "*Chiton magellanicus*, Chem.; *Chiton georgianus*, Q. et G. Type figured. Port du Roi George, New Holland, Expedition d'Urville, 1824, the figure in Voy. Astrol., pl. 75, figs. 25-30, agrees with these specimens."

Liolophura (Chiton) gaimardi, Blainville (Dict. Sci. Nat., xxxvi., p. 546, 1825). The type was collected at Port Jackson by Quoy and Gaimard and was preserved in spirit. This bottle contains two specimens with a more recent label, "*Acanthopleura magellanica*, Chem." These may be the types, as the type is referred to as being in the Paris Museum in the catalogue of that Museum, dated 1838., *Onithochiton (Chiton) undulatus*, Quoy et Gaimard. Type (Zool. de l'Astrol., p. 393, t. 75, f. 19-24, New Zealand). The label is in the handwriting of Quoy or Gaimard, "Pl. 75, figs. 19-24, 1833." This corresponds with specimens in my own collection from Doubtless Bay, New Zealand, except that in the type the diagonal rib is almost smooth, showing little granulation. The shells are bleached.

Onithochiton astrolabei, Rochebrune. Type (Bull. Soc. Philom., Paris, 1880-81, p. 120), New Zealand, Quoy et Gaimard, 1829. This shell has spaced granules in the diagonal rib similar to my Doubtless Bay specimens, and is only a slight variation from the type of Quoy and Gaimard's *undulatus*.

Onithochiton neglectus, Rochebrune. Type (Bull. Philom., Paris, 1880-81, p. 120), Wellington, New Zealand, Quoy et Gaimard. This is an exceptionally granulose shell, probably a variety of Quoy et Gaimard's *undulatus*, but as that name was preoccupied Iredale substituted the name *neglectus*, Rochebr. (Trans. N. Z'd. Inst., vol. xlvii., 1914).

Onithochiton lyelli, Sow. There is in spirit a rather worn specimen from Ile Pitcairn. This seems conspecific with *O. quercinus*, Gould.

Gymnoplax adelaidensis, Quoy et Gaimard, 1829. This is an East Indian shell from Amboine. It has scales like a *Haploplax* and resembles members of that genus in general shape, but there the resemblance ends, the valves being very strongly sculptured. I have no reference to its description.

ECOLOGICAL NOTES ON SOUTH AUSTRALIAN PLANTS.
PART 1.

By ERNEST H. ISING.

[Read October 19, 1922.]

PLATES XXXVIII TO XLII.

I INTRODUCTION.

These notes are the result of a trip taken along the Transcontinental Line between Hughes and Kingoonya from September 5 to 24, 1920 Collections of plants were made at the following places showing the number of miles from Port Augusta:—Hughes, 567 miles; Ooldea, 427 miles; Immarna, 407 miles; Barton, 376 miles; Wynbring, 321 miles; Tarcoola, 257 miles; and Kingoonya, 209 miles.

The rainfall over the area collected had been heavier that year than for a number of years, resulting in splendid growth of native vegetation. Seeds that were dormant for a number of years must have germinated that year, for there was an abundance of plants at all the places visited.

Reference will be made in this paper to the ecological factors noted in connection with the plants seen and collected at the various places mentioned. Plants were collected up to three miles from the centres referred to.

Throughout the trip I was helped very considerably in collecting and drying by Mr. A. M. Lea, F.E.S., Government Entomologist, who was collecting insects for the Museum on the same trip.

An asterisk denotes an introduced plant. These were not seen to any extent and only close to the railway stations.

For assistance in identifying some of the specimens I am indebted to Mr. J. H. Maiden, I.S.O., F.R.S., F.L.S., etc., Director Botanic Gardens, Sydney *(Eucalyptus* and *Acacia)*, Mr. J M. Black, and Professor T. G. B. Osborn, D.Sc.

II. PHYSIOGRAPHY.

1. THE NULLARBOR PLAIN.

Size.—The Nullarbor Plain commences at Ooldea at its eastern boundary and stretches away westward to the border for 170 miles, and thence into Western Australia. Its southern boundary is the coastline of the Bight, and it extends for about 100 miles north.

The Little Plain.—At 441 miles from Port Augusta a ledge is met with which is the edge of the Nullarbor Plain proper This is 17 miles west of Ooldea, and it forms a "little plain" which is quite distinct from the big plain further west. This small area is of an undulating character and grows a number of trees and small shrubs which appear to frequent the depressions. On the Nullarbor Plain, itself, this bigger growth disappears. It is on this small strip of country that the florulas of the plain and the sandhills meet, but there is very little invasion by the different plants on the neighbouring territory.

The Plain Proper.—The Nullarbor Plain stretches away north, south, and west from the "ledge" in an unbroken expanse of level, or slightly undulating, country as far as the eye can see. From the "ledge" (441 miles) to Hughes (567 miles), which is within 32 miles of the Western Australian border, the country is the same uninteresting plain not relieved by any prominence whatever. Slight undulations occur, in places, and are from a quarter to half a mile, or more, across; but the resulting rises and depressions would only be about 4 ft. or 5 ft. above or below the surrounding level. The rises, generally, have an outcrop of limestone with weather-worn fragments of the same lying around. The top soil, held together by the plants, is a reddish, friable, sandy loam which extends for at least 12 in. below the surface. In places it is of a clayey nature. In the depressions there is no surface limestone. These shallows (one large one at Hughes is called "The Dry Lake") grow fewer plants than the higher levels, and in them the "Australites," or "Obsidian bombs," are more readily found. The hollows do not hold water long. While we were at Hughes an inch of rain fell in one day, but there was no water in the "lake" next day.

Several "blowholes" were seen at Hughes. They were about 15 ft. deep and about 3 ft. wide, with limestone ledges forming the sides. The bottom was soon reached by dropping a stone down, and no movement of air was observed going in or coming out.

2. THE SANDHILLS.

The sandhills commence at about 324 miles from Port Augusta, where they leave the stony undulating country. The sandhills are small at first but increase in size until some of them are 30 ft. to 40 ft. high and run in ridges for long distances. These ridges trend in almost every direction. At Ooldea they are east and west, and north-east and south-west. At Barton they are about east and west. The sand is fine and chiefly pinkish in colour; at Ooldea Soak, three miles north of the railway station, where the sandhills are very big, the sand is almost white At about 15 ft below the surface at the Soak a very light-coloured clay is reached. This clay is very stiff and forms an impervious bottom for the wells that have been sunk The wells are not sunk lower than the above depth and are timbered all the way down The water soaks in within a few hours to about 3 ft. of the surface. There are eighteen wells at this spot and they are situated in a hollow surrounded by high sandhills. Twelve of them produce beautiful, fresh, drinking water, while the other six are fit for human consumption but slightly brackish.

There is no doubt this fresh water has been known to the natives for many miles around for generations, as native flint chippings can still be picked up in handfuls around the wells It is a veritable oasis, and has been made use of by early explorers The sandhills are clothed with a dense vegetation comprising trees (up to 40 ft. or more in height), shrubs, undershrubs, small perennials and annuals. A fine view was obtained from the top of a tall sand ridge at the Soak, and the prevailing mallee sandhill scrub stretched away to the north, east, and south as a dark expanse of country.

For most of the year the plants of the sandhills are subjected to very severe growing conditions, and transpiration must be at its maximum during that period. Such conditions tend to keep an open formation; that is, plants have open spaces between them of some yards. Yet often in the hollows between the sand ridges the Acacias and other shrubs are so close together that they touch one another, and one has to push a way through them. The vegetation has responded to its environment by developing narrow leaves (or phyllodes in the case of the Acacias), thus reducing transpiration to a minimum. The broad-leaf plants, such as Eucalypts (*E. oleosa*, *E. pyriformis*, and *E. transcontinentalis*), have responded to the prevailing meteorological and edaphic factors by producing coriaceous leaves with few stomata which are deeply set below the epidermis. The small herbaceous annuals grow chiefly out in the open, it was rare to find them growing below the larger shrubs or trees. The annuals consisted largely of composites, although *Calandrinia polyandra*, the "parakeelya," formed large patches around Barton.

The sandhills are fixed, being clothed with native vegetation. When the covering is removed trouble is experienced with drifting sand. This has been the case in some of the railway cuttings, which have had to be faced with a retaining mat consisting of stakes, boughs, and small branches.

The sandhills grow a greater number of plants than any other portion of the country visited along the line.

3. THE COUNTRY AROUND TARCOOLA AND KINGOONYA

At about 324 miles from Port Augusta, near Wynbring, the sandhills disappear and an undulating stretch of country is entered upon, which continues to Kingoonya. At Tarcoola there are some small hills, the sloping sides of which are thickly strewn with rock fragments, about 4 in square

III. Plants of the Nullarbor Plain.

General.—There are two main types of plants at Hughes: *(a)* shrubs of about 50 cm. in height, and *(b)* small herbs and grasses. This formation was constant, as far as observed, for 140 miles between Ooldea and Hughes. It was the result, no doubt, of the uniform character of the surface topography, soil, and rainfall The shrubs include a very few tall ones of *Pittosporum phillyraeoides* and *Acacia tetragonophylla*, and it is a remarkable fact that there are so few of them.

The plants may be considered according to their height.

1. The tallest plants were shrubs, 2 to 3 m in height, consisting of "dead finish," *Acacia tetragonophylla* (only one plant seen, 3 m. in height), and the "Weeping Pittosporum," *P. phillyraeoides*, of which only a few shrubs came under notice.

2. The bluebush and saltbush shrubs varied from a half to one metre in height, and were the dominant shrubs of this vast treeless, riverless plain.

3. The undershrubs and larger perennials and annuals, of from 20 to 45 cm. in height, formed this third range of plants, and consisted of species of *Kochia*, *Bassia*, *Blennodia*, *Swainsona*, composites and grasses.

4. The ground flora of only a few inches in height was represented by composites, and by *Calandrinia*, *Daucus*, *Erodium*, *Euphorbia*, *Lepidium*, *Lotus*, *Nicotiana*, *Plantago*, *Tetragonia*, *Crassula*, and *Zygophyllum* species. This arrangement, however, does not give the ecological relationships which I wish to emphasize.

The following formations, which are of the open type, were noted on the plain.

Bluebush Formation.

Pl. xl., fig. 1.

The Nullarbor Plain is not a dead level, but consists of undulations, forming slight rises and shallow depressions, varying from 1 to 2 metres. The bluebush *(Kochia sedifolia)* was not confined to either the rises or the hollows, but it was noted that this shrub dominated an area of several hundred square yards in extent. The saltbush *(Atriplex vesicarium)* was not completely excluded from this region, but the bluebush gave it a characteristic blue-grey appearance. A very prominent species in this formation is *Goodenia pinnatifida*, which covered numerous areas and ranged from 10 to 12 cm. high. It was in full flower at the time of my visit (September 8) and was a beautiful sight. *Podolepis canescens* was found in this station, and it is a larger plant than the previous one but not nearly so plentiful. It brightened the dull hue of the bluebush foliage.

To be seen in some numbers with the above plants was an interesting variety of *Calotis multicaulis* (n. var. *breviradiata*, see p. 604), a small diffuse herb 5 to 20 cm. in height. It was growing in little colonies of about a metre across Another plant growing chiefly in colonies, but much more plentiful than the last species, was *Cephalipterum Drummondii*, a species with dense white heads. Some specimens collected were remarkably small, being only 3½ cm. in height, while the largest were 15 cm.

The following plants were often found in association, usually in small depressions in which water remained for a short period after the rain:—

Helipterum strictum, growing up to 25 cm. in height and dominating the association. *Vittadinia australis*, in lesser numbers and not so high. *Daucus glochidiatus*, about 20 cm. in height. *Podocoma nana*, plentiful, but only up to 8 cm. in height; this is the first record of this plant for Nullarbor Plain. *Crassula Sieberiana*, varying from 3 to 6 cm. *Tetragonia expansa*, a plant quite prostrate and spreading 20 cm. or more. *Plantago varia*, the smallest plant in the colony, being only 3 cm.(?) or less in height. And *Calandrinia pusilla*, another small annual.

A small sticky composite (*Helipterum tenellum*) formed areas of several square feet; the plants ranged from 6 to 18 cm. in height. Smaller still, and growing together, were *Bassia sclerolaenoides* and *B. patenticuspis*, which formed an open association. Two species of *Zygophyllum* (*Z. iodocarpum* and *Z. ovatum*) were associated and grew in considerable numbers where the ground was subject to flooding. A small composite (*Minuria leptophylla*) was not often seen, but *Gnephosis skirrophora* was much more plentiful. A dwarf annual crucifer (*Thlaspi Drummondii*) was fairly common in this station, as was also *Lepidium rotundum*, DC., var. *phlebopetalum*, Maid. et Betche, a plant only 4 to 8 cm. in height. The tiny annuals—*Plantago varia*, *Calotis hispidula*, and *Isoetopsis graminifolia*—were fairly numerous between the bluebush shrubs. A common composite was *Vittadinia australis*, and one, much less so, was *Elachanthus pusillus*, and an annual that grew in numerous patches was *Siloxerus brachypappus*, which is a small diffuse annual of from 2 to 6 cm. in height. This latter plant was a notable feature in many places on the Nullarbor Plain visited. Two dwarf plants not often met with were *Erodium cygnorum* and *Convolvulus erubescens*. At the time of my visit the most abundant plant, and the one which covered a large area, was the white everlasting *Helipterum floribundum*. It is a very showy annual growing up to 25 cm.

The woolly bluebush (*Kochia villosa*) was a rare plant on the Nullarbor Plain, as also was *K. Georgei;* they were smaller plants than the typical bluebush (*Kochia sedifolia*). Growing among species of *Zygophyllum* were plants of *Lepidium papillosum*. The introduced pest **Emex australis* was spreading in the open spaces near the railway line at Hughes. Another rare plant was *Lepidium fasciculatum*, but was more plentiful around Tarcoola. Two plants found in open association were *Swainsona Oliveri* and *Sida corrugata*, var. *orbicularis*. Among the rare species were noted *Salsola Kali*, var. *strobilifera*, *Senecio brachyglossus*, *Euphorbia Drummondii*, and *Minuria Cunninghamii*. Three grasses were identified: *Stipa eremophila* and *S. scabra*, var. *auriculata*, and the dwarf *Danthonia penicillata;* the two former were much more plentiful than the latter.

Saltbush Formation.

The saltbush (*Atriplex vesicarium*), like the bluebush, is a perennial shrub of about 60 cm. in height. Usually it is just a little shorter than the bluebush, and the two species form the main vegetation of the Nullarbor Plain.

On the whole, the species observed in association with the bluebush were also noted among the saltbush. There were, however, certain plants only seen with the saltbush. In depressions there was less vegetation than on the higher ground; the smaller plants (annuals chiefly) were absent, and the formation was decidedly an open one. It was in this station only that the following plants were seen:—*Eremophila maculata*, a shrub about 45 cm. in height; *Atriplex campanulatum*, a small saltbush 25 cm. in height; spear grass, *Stipa eremophila* (also observed in the bluebush formation); *Blennodia trisecta;* and the decumbent plant, *Frankenia pauciflora*. The annuals were of few species and sparsely distributed, including *Lotus australis*, var. *parviflorus*, a plant with prostrate stems and often spreading to 1 m. across; *Lavatera plebeia*, of about 30 cm. in height; small plants of *Nicotiana suaveolens;* and *Swainsona phacoides*, often wide spreading.

The Plain and Sandhills.

There is not much change in the general aspect of the flora where the Nullarbor Plain joins the sandhill region. Just before leaving the "Plain" the "dead finish" (*Acacia tetragonophylla*) becomes more plentiful, but it was seldom seen in the sandhill country The following plants were noted just west of the sandhills and were common to both types of country:—*Goodenia pinnatifida*, *Cephalipterum Drummondii*, *Calotis hispidula*, *Kochia sedifolia*, *Stipa scabra*, var. *auriculata*. There is very little overlapping of the plants of the two regions.

IV. THE SANDHILLS FLORA.

1. OOLDEA DISTRICT

The sandhills' flora is of a typical sclerophyllous nature, and here again the formation is of an open character.

Trees.—The trees and larger shrubs usually have reduced leaf surfaces. In the case of *Casuarina lepidophloia* the leaves are represented by very small sheathing teeth, and the branchlets are only 1 mm. in width. *Myoporum platycarpum* was sparingly distributed, and much less so was *Heterodendron oleaefolium*, both of which have flat leaves. The latter was usually found with *Acacia ramulosa* in the flats between the sand ridges. The mallees were not so plentiful as the wattles, and two of the broad-leaved Eucalypts were *E. oleosa* and *E. transcontinentalis* (pl. xxxix., fig. 2), which formed the bulk of the mallees. *E. pyriformis* seemed confined to a small patch at Ooldea Soak. Among other mallees were *E. uncinata* and *E. gracilis*, forming large shrubs and growing interspersed with *Acacia ramulosa*. The quandong (*Fusanus acuminatus*) was not common and seemed to prefer the sand ridges.

Shrubs.—The phyllodes of some of the acacias were narrow and hard, such as *A. tetragonophylla*, *A. colletioides*, *A. ramulosa*, and *A. aneura*, the last two being more plentiful; while *A. Randelliana* and *A. Burkittii* were not seen to any extent. Of those with broader phyllodes *A. Kempeana*, *A. Osswaldii*, and *A. ligulata* were fairly numerous. Other shrubs were *Eremophila alternifolia*, which was seen in fair numbers and often associated with *Casuarina lepidophloia*; *Eremophila Latrobei* and its variety *Tietkensii* were the next most plentiful, but *E. Gibsonii* was rare. Two grevilleas (*G. pterosperma* and *G. stenobotrya*) were usually seen growing on the flat ground, but of infrequent occurrence. The parasites, *Loranthus linophyllus* and *L. pendulus*, were somewhat rare, the former growing on *Heterodendron oleaefolium* and the latter on *Eucalyptus transcontinentalis*. *Rhagodia*

Billardieri formed tall shrubs and was often seen among acacias. In the wide open flats, between some of the smaller sand ridges, were seen shrubs of *Cratistylis conocephala* and *Westringia Dampieri*, var. *rigida*, and *Bassia echinopsila* was associated with them. Two other shrubs, *Cassia eremophila* and *C. Sturtii*, were fairly common in the sandhill region, with *Dodonaea attenuata* as a rare species

The Ground Flora.—By the ground flora is meant the undershrubs and annuals which range from 2 to 25 cm. in height. The dominant species were *Cephalipterum Drummondii*, *Waitzia acuminata*, and *Helipterum floribundum;* they are annuals and grow in open association. Some plants preferred the sand ridges (often in the open and seldom in the shelter of other larger plants), *viz.*, *Waitzia acuminata*, *Calandrinia disperma*, *Stackhousia muricata*, *Podotheca angustifolia*, and *Pomax umbellata*. The latter species and the *Stackhousia*, developed a long slender tap-root which, no doubt, penetrated the loose sand to the moisture below; the lateral rootlets were not robust, as the plants depended on depth of root rather than on spread. The poor rainfall (see table) of the district and the intense heat, combined with an extreme evaporation, tends to the production of an elaborate root system. This is specially necessary in the plants growing along the tops of the sandhills. Growing chiefly on the flats, between the sandhills, were: *Zygophyllum fruticulosum*, *Euphorbia Drummondii*, varieties of *Sida*

RAINFALL FOR

	1914	1915	1916	1917	1918	1919	To Aug. 31,1920	Average
Hughes ...	—	—	—	—	—	6·12	—	—
Ooldea ...	—	—	—	—	7·35	6·75	4·29	7·05*(2)
Immarna ...	—	—	—	—	—	6·65	5·14	—
Barton ...	—	—	—	—	7·63	6·44	4·35	7·03*(2)
Tarcoola ...	5·28†	3·76	7·92	9·20	7·49	7.35	5·87	7·33*(17)
Kingoonya ...	—	—	8·00	8·65	5·76	5·82	6·87	7·05*(4)
Eucla	9·00	7·88	10·97	12·77	9·51	10·70	5·18	10·05*(44)
Port Augusta ...	6·44	8·80	11.26	13·67	7·58	9·67	7·76	9·43*(60)

* ( ) Number of years for average
† These totals are shown in inches

corrugata, in open association, while *Uldinia mercurialis*, *Lappula concava*, *Calotis hispidula*, and *Daucus glochidiatus* formed patches often in association with one another. Also on the flats, *Velleia paradoxa* was found associated with the annual plant *Brachycome ciliaris*.

2. OOLDEA SOAK.

At Ooldea Soak, where a wonderful supply of fresh water is obtainable at a shallow depth, some of the vegetation is luxuriant; for instance, *Myriocephalus Stuartii* formed a veritable carpet where it grew in the hollows near the wells. Associated with this plant was *Senecio Gregorii* and large shrubs of *Leptospermum laevigatum*, var. *minus* (pl xxxix., fig. 2), although I also noted the latter species some miles from the Soak growing on a sand ridge. In the hollow, where the wells are situated, was found the "water-bush, *Adriana Hookeri*, and ascending the sandhills, to the west, *Melaleuca parviflora* and *Acacia ligulata* were met with, while *Gyrostemon ramulosus* was only seen on the ridges.

3. BARTON DISTRICT.

Barton is situated in the centre of the sandhill tract and is similar country to Ooldea. Its flora, too, is similar, only slight differences being noted. Twenty-six of the species noted here were not recorded from Ooldea, while 67 species collected at the latter place were not seen at Barton. The type of plants was the same as at Ooldea, *Casuarina lepidophloia*, however, was more plentiful, although it could hardly be said to dominate the flora. There was the usual *Acacia-Eucalyptus* association with *Acacia ramulosa* and *Eucalyptus oleosa*, as the dominants, particularly the former. The former species was met with almost everywhere (sometimes in a semi-closed formation), while the latter was reduced to a clump, here and there. Although the season (1920) had been a good one hardly a seedling was seen of either of these species. An occasional clump of *E. transcontinentalis* was seen, while a clump of mallee (*Eucalyptus oleosa*, pl. xli., fig. 1), remarkable for its prostrate trunks, covered a patch about 10 yards across, situated in a hollow between the usual sand ridges. Only two or three of the trunks were upright and were about 3 m. high; the others were lying on the ground, right from their base. The middle of the trunk was somewhat arched and the branches were horizontal. The aphyllous shrub, *Bossiaea Walkeri*, seemed to prefer the lower situations and often formed large thickets. The flattened stems exude quite a quantity of smooth white powder while drying. *Dodonaea microzyga* was not plentiful, nor was *Olearia subspicata*, and both grew on the flats with *Casuarina*, *Grevillea Huegelii*, and *Acacia colletioides*. *Eremophila scoparia* was associated with *Cassia eremophila* and *C. Sturtii*, and, in places, formed quite a distinct feature of the vegetation. *Thryptomene Elliottii* was seen on a sand ridge at Barton.

In a photograph (pl. xli., fig. 2) taken at Barton *Thryptomene Elliottii* is seen in the foreground with *Casuarina lepidophloia* and *Eucalyptus* close by. In another situation, *Casuarina lepidophloia* is growing with acacias, mallee, and *Triodia irritans*. This latter plant was fairly common at Barton, and, in another place, it was noticed associated with *Solanum coactiliferum*, *Acacia ligulata*, and *Thryptomene Elliottii*. The common "parakeelya" (*Calandrinia polyandra*) of the sandhills was growing so profusely in places that it became almost a closed formation, its associates in one place were *Helichrysum lucidum* and *Solanum orbiculatum*. In open, flat ground *Trichinium corymbosum* and *Podolepis capillaris* were associated; they are both small annuals.

V. DESERT FORMATIONS OF THE TARCOOLA REGION.

CLIMATIC AND EDAPHIC FACTORS.

The sandhill region is left at Wynbring, where, travelling east, an undulating stony country is entered upon. As was to be expected, the flora changed as soon as the sandhills were left behind. The vegetation now was not so dense or plentiful, no doubt caused by the dry subsoil. The top soil is of a clayey nature in this region and surface water would remain longer than in the sandhills. In the sandy country more moisture reaches the subsoil, which proves to be of a wonderfully retentive nature; there is, consequently, a greater amount of moisture available for the plant covering. This influences the flora of the two regions under discussion.

KOCHIAS AND ACACIAS OF TARCOOLA.

The predominating species in this station is *Kochia sedifolia* and *Acacia Loderi*, while *Kochia triptera* and *Eremophila rotundifolia* are represented by numerous plants. Also *Acacia aneura* claims attention, as it was frequently seen; *Hakea leucoptera* was not so plentiful. The plants on top of a rocky hill (pl. xlii., fig. 1) consisted of *Acacia tarculensis* and *Trichinium incanum*, which were the dominants; here and there *Rhagodia Gaudichaudiana* and *Enchylaena tomentosa* were seen, while the smaller plants, *Helipterum Fitzgibbonii* and *H. pterochaetum* were fairly numerous. The rocky slopes of the low hills have a distinctive flora, and, besides the prevailing bluebush, *Helipterum Humboldtianum*, is seen along a small dry watercourse, and associated with it is *H. moschatum*. Larger plants here were *Sida calyxhymenia* and *Atriplex vesicarium*.

Where the slopes led into more flat country *Kochia pyramidata* and *Clianthus Dampieri* were associated, and, in open formation with the bluebush, the following plants were noted:—*Kochia villosa*, *Bassia diacantha*, *B. paradoxa*, and *Salsoli Kali* is only represented by its variety *strobilifera*, and it was rare here, as it was on the Nullarbor Plain.

Coming right down to the depression at the base of the hill near Tarcoola, the succulents, *Aizoon quadrifidum*, forming small shrubs, and *Tetragonia expansa*, were in association with a few plants of *Zygophyllum Billardieri*, var. *ammophilum*, with them.

On the extensive clay flats the tall *Acacia aneura* was the dominating species, and *Calogyne Berardiana* was also very plentiful, and formed large patches in places with associations of *Goodenia pinnatifidia* and *G. pusilliflora*. Growing in the shelter of the former were *Abutilon oxycarpum* and *Euphorbia eremophila*. In this formation was also seen *Brachycome ciliaris*, *Cephalipterum Drummondii*, *Lepidium rotundum*, var. *phlebopetalum*, *Calotis hispidula*, *Stenopetalum lineare*, *Erodium cygnorum*, and *Millotia tenuifolia*, the first species being the most plentiful.

Where the soil was of a more sandy loam in this area the vegetation was more pronounced. Several patches of this nature were seen, and the predominating plants were *Helichrysum Lawrencella*, var. *Davenportii*, *Craspedia pleiocephala*, *Myriocephalus Stuartii*, *Swainsona phacoides*, and *S. microphylla*, the last two specially so. A few plants of *Calotis multicaulis*, *Templetonia egena*, and *Helipterum floribundum* were not so common. In a small depression, *Frankenia serpyllifolia* had almost made a closed formation. No eucalypts were seen at Tarcoola, but scattered species of *Eremophila* were noted as follows:—*E. Duttonii*, *E. glabra*, *E. latifolia*, *E. Latrobei*, and *E. Paisleyi*, besides those already mentioned.

KINGOONYA PLAIN.

The dominant species of the plain was *Acacia Loderi*, and with it was associated *Minuria leptophylla* (pl. xlii., fig. 2). The shrubs noted were *Rhagodia Gaudichaudiana*, *Kochia triptera*, *K. villosa*, *Cassia Sturtii*, *Eremophila alternifolia*, *E. Latrobei*, and *Bassia paradoxa*. Smaller plants were *Bassia sclerolaenoides*, *Rutidosis helichrysoides*, *Ixiolaena leptolepis*, and *Leptorrhynchus tetrachaetus*, var. *penicillatus*, and were only represented by few specimens. In other formations were *Blennodia trisecta*, *Menkea australis*, *Clianthus*

Dampieri, *Podocoma nana*, *Gnephosis cyathopappa*, *Helipterum Charsleyae*, *H. stipitatum*, and other small annuals.

Where the ground was lowlying the grass *Eragrostis Dielsii* was recorded, and with it were *Swainsona Oliveri*, *Tribulus terrestris*, *Zygophyllum fruticulosum*, *Z. ovatum*, and *Isoetopsis graminifolia*.

VI. A CENSUS OF AND NOTES ON PLANTS COLLECTED.

References:—H., Hughes; O., Ooldea and Ooldea Soak; I., Immarna; B., Barton; W., Wynbring; T., Tarcoola; K., Kingoonya. The numbers following the capital letters refer to my specimen number. The above places are in Tate's District W, as shown in Tate's "Flora of Extrat. South Australia," p. 204. Where a plant is new for this district, "Dis. W." is shown. An asterisk denotes an alien species.

POLYPODIACEAE.

Cheilanthes tenuifolia, Swartz. T. 1726.

MARSILIACEAE.

Marsilia Drummondii, A. Br. K. 1846. Appears to be this species, although the sporocarps are very shortly stalked (3-4 mm.) and the cases are about the same length, hairy, and with a few oblique transverse ridges. Leaflets ovate-cuneate, hairy, but becoming glabrous with age. Near *M. hirsuta*, R. Br.

SCHEUCHZERIACEAE.

Triglochin centrocarpa, Hook. O. 1609, T. 1799.

My plant No. 1609 agrees well with the illustration (pl. iv., 2) by Ostenfeld in Dansk Bot. Arkiv., Bd. 2, Nr. 8, 1918, but they are taller, *i.e.*, 13 cm. high. The flowers are distinctly pedunculate.

The Tarcoola specimen (No. 1799) is only 3·5 cm. high; the fruits are as long as No. 1609, but the spur is more pronounced.

GRAMINEAE.

Identified by Mr. J. M. Black.

Panicum leucophaeum, H. B. et K. T. 1648.

Pappophorum nigricans, R. Br. T. 1642, 1644.

Stipa eremophila, Reader. H. 1636.

S. scabra, Lindl. W. 1216.

S. scabra, Lindl., var. *auriculata*, J. M. Black. H. 1637, O. 1640.

Aristida stipoides, R. Br. T. 1643.

Danthonia penicillata, (Labill.), F. v. M. H. 1638-9, K. 1649-50.

Diplachne loliiformis, F. v. M. K. 1647.

Triodia irritans, R. Br. O 1293, I 1246, B. 1317.
Eragrostis Dielsii, Pilg. K. 1646
E. eriopoda, Benth. T. 1411.
E. eriopoda, Benth., var. *laniflora*, J. M. Black. O. 1641.

LILIACEAE.

Thysanotus exiliflorus, F. v. M. O. 1625. Petals in my specimens are not minutely fringed, but it agrees with the above otherwise.

CASUARINACEAE.

Casuarina lepidophloia, F. v. M. O. 1479, B. 1705. Teeth, 8 or 9; cones, 12 to 15 mm. long.

URTICACEAE.

**Humulus*, sp. O 1282. A single specimen growing near the ballast on the railway line.

PROTEACEAE.

Grevillea Huegelii, Meisn. B. 1339.
G. pterosperma, F. v. M. O. 1302, B. 1383
G. stenobotrya, F. v. M. O. 1302a. In bud only, September 16, 1920.
Hakea leucoptera, R. Br. T 1785. "Dis. W."

SANTALACEAE.

Fusanus acuminatus, R. Br. O. 1614, K. 1832, B. 1706.

LORANTHACEAE.

Loranthus linophyllus, Fenzl. O. 1589. Growing on *Heterodendron oleaefolium*, Desf.
L. pendulus, Sieb. O. 1289. Of pendulous habit growing on *Eucalyptus transcontinentalis*, Maiden.

POLYGONACEAE.

**Emex australis*, Stein. H. 1547a, T. 1777.

CHENOPODIACEAE.

Atriplex campanulatum, Benth. H. 1508, O. 1602. "Dis. W."
A. spongiosum, F. v. M. B. 1360, K. 1807.
A. vesicarium, Hew. H. 1228, 1259, 1260, 1511, 1541, 1541a, 1565a, W. 1395, T. 1714, 1761. The fruits of this species vary a good deal. In one specimen from the Nullarbor Plain (No. 1565a) the appendages have thick prickle-like lobes covering them. In No. 1761 the fruiting calyx is entire, semi-orbicular, and with very small appendages; the leaves are small, mostly orbicular-ovate.

Rhagodia Billardieri, R. Br. O. 1604.

R. Gaudichaudiana, Moq. O. 1620, B. 1351, W. 1202, T. 1408, K. 1836.

Chenopodium cristatum, F. v. M. O. 1701, B. 1384.

Enchylaena tomentosa, R. Br. B. 1331, T, 1778.

Kochia Georgei, Diels. H. 1226, 1542-3, T. 1723, 1756. First record for Nullarbor Plain, Tarcoola, and for the State. Originally described from Western Australian specimens by Diels and Pritzel in Bot. Jahrb., 184, 1904, with a figure of fruit (fig. 20, D). Previously confused with glabrous forms of *K. villosa*, but the obconic base of the fruiting perianth is a very distinct feature.

K. pyramidata, Benth. T. 1788.

K. sedifolia, F. v. M. H. 1227, 1258, 1544. T. Neither in flower nor fruit.

K. triptera, Benth. T. 1763, K. 1829.

K. triptera, Benth., var. *erioclada*, Benth. O. 1235, B. 1380, T. 1724, 1762.

K. villosa, Lindl. O. 1286, T. 1722, 1742, K 1833.

Bassia biflora, F. v. M. K. 1805. "Dis. W"

B. diacantha, F. v. M. T. 1718, 1737, 1757.

B. echinopsila, F. v. M. O. 1275, B. 1708.

B. eriacantha, F. v. M. (*B. lanicuspis*, F. v. M.). T. 1752.

B. sp.(?) O. 1284, 1603.

B. paradoxa, F. v. M. T. 1743, K. 1808.

B. patenticuspis, R. H. Anderson. H. 1230, 1513, 1548, O. 1285. This identification was made by Mr. J. M. Black, who advises that Mr. R. H. Anderson, of Sydney Botanic Gardens, is engaged on a revision of the Australian genus *Bassia* and has recently created this new species.

B. sclerolaenoides, F. v. M. O. 1567, 1578, T. 1766, K. 1809. "Dis. W."

Pachycornia tenuis, (Benth.) J. M. Black. T. 1761. "Dis. W."

Salsola Kali, L., var. *strobilifera*, Benth. H. 1569, T. 1793.

AMARANTACEAE.

Trichinium alopecuroideum, L. O. 1238, 1627, B. 1702, T. 1721.

T. corymbosum, Gaud. B. 1311, T. 1798.

T. exaltatum, Benth. O. 1287, 1626.

T. incanum, R. Br. O. 1264, 1628, T. 1407, 1746.

PHYTOLACCACEAE.

Gyrostemon ramulosus, Desf. O. 1303.

AIZOACEAE.

Tetragonia expansa, Murray. H. 1536, T. 1732, 1186.

Aizoon quadrifidum, F. v. M. T. 1760.

PORTULACACEAE.

Calandrinia disperma, J. M. Black. O. 1588.

C. polyandra, Benth. O. 1236, 1276, 1605, 1606, B. 1232, 1385. Nos. 1276, 1605, and 1385 are the white-flowered variety.

C. pusilla, Lindl. H. 1546, I. 1249, B. 1365, 1387, T. 1769. No. 1387. Plant larger than usual and more branching, stems 18 cm. long, racemes many-flowered.

CARYOPHYLLACEAE.

Spergularia rubra, Camb. K. 1840.

PAPAVERACEAE.

**Papaver hybridum*, L. O. 1697.

CRUCIFERAE.

Blennodia canescens, R. Br. W. 1393, T. 1717.

B. curvipes, F. v. M. T. 1767.

B. trisecta, Benth. H. 1257, 1549, K. 1810.

**Sisymbrium orientale*, L. O. 1698, T. 1195, 1196. Of the introduced species this one was the most common.

Stenopetalum lineare, R. Br. O. 1262, B. 1364, T. 1748, K. 1839. "Dis. W."

Menkea australis, Lehm. T. 1830, K. 1831. "Dis. W."

Thlaspi Drummondii, Benth. H. 1520, 1700. A rare plant only collected on the Nullarbor Plain (*Capsella Drummondii*, F. v. M.).

Lepidium fasciculatum, Thell. H. 1554, K. 1834. "Dis. W."

L. papillosum, F. v. M. H. 1593, O. 1547, T. 1201.

L. rotundum, DC. T. 1189. "Dis. W."

L. rotundum, DC., var. *phlebopetalum*, Maid. et Betche. H. 1241, O. 1521, T. 1790. "Dis. W."

CRASSULACEAE.

Crassula colorata, (Ness.) Ostenf. T. 1776a.

C. Sieberiana, (Schult.) Ostenf. H. 1545, T. 1775.

PITTOSPORACEAE.

Pittosporum phillyraeoides, DC. H. 1550.

LEGUMINOSAE.

Daviesia ulicina, Smith. B. 1367. It was quite a surprise meeting this plant, which is usually found in the Mount Lofty Range and the south-east of the State. Only one plant was seen, and was nearly 2 metres high; the bark was dark, rough, and ribbed. The flowers are in short axillary umbels, with the pedicels longer than the peduncle. "Dis. W."

Bossiaea Walkeri, F. v. M. B. 1217, I. 1244. In flower September 5, 1920. Young branches silky with dense adpressed hairs.

Templetonia egena, Benth. T. 1729.

Clianthus Dampieri, Cunn. T. 1772, K. 1814.

Swainsona Burkei, F. v. M. I. 1247 "Dis. W."

S. microphylla, A. Gray. T. 1725, 1739. The leaflets vary a good deal in size and shape. I have them from 6 to 12 mm. long and from ovate to oblong.

S. Oliveri, F. v. M. H. 1563, K. 1841.

S. phacoides, Benth. H. 1256, 1539, W. 1394, T 1740. "Dis. W."

Psoralea patens, Lindl. K. 1835.

Lotus australis, And., var. *parviflorus*, Benth. H 1564. Flowers pink.

Cassia artemisioides, Gaud. T. 1749.

C. eremophila, Cunn. O. 1283, B. 1707.

C. eremophila, Cunn., var. *platypoda*, Benth. O. 1272, 1577, 1608, T. 1416.

C. Sturtii, R. Br. O. 1271, 1280, B. 1332, T. 1771, K. 1812.

Acacia species identified by Mr. J. H. Maiden, I.S.O., F.R.S., etc.

Acacia aneura, F. v. M. O. 1273, 1487, B. 1329, T. 1413, 1498. No. 1498 is a small intricate shrub of nearly 1 metre high. The branches are somewhat angular with white scaly angles or lines; the phyllodes are short and broad. Altogether the plant is very different from the typical tree; this may be accounted for by the fact that the only shrub seen was growing among rocks on the top of a rise near Tarcoola. Not in flower or fruit.

A. brachystachya, Benth. T. 1414.

A. Burkittii, F. v. M. O. 1486.

A. colletioides, Cunn. O. 1298, B. 1341.

A. *Kempeana*, F. v. M. O. 1491, B. 1338(?).

A. *Loderi*, J. H. Maiden. T. 1496, 1499, 1500, K. 1501. New for South Australia. Mr. Maiden described it in the Proc. Roy. Soc. N.S. Wales, vol. liii. (1920), p. 209, from Broken Hill specimens. It is a small tree 3-5 cm. high with branches and phyllodes fairly erect. The phyllodes vary from 25 to 90 mm. long and 1 to 2 mm. wide. Veins about 10, the central one on the surface of the phyllode is somewhat ridged. Pods almost sessile, light brown, 25-40 mm. long and 2·25 mm. wide. ("Nos. 1500 and 1501 are more glabrous forms with narrower phyllodia."—J. H. M.)

A. *Oswaldii*, F. v. M. O. 1494, B. 1345.

A. *Prainii*, J. H. Maiden. B. 1330. New for South Australia. Mr. Maiden's description is to be found in the Proc. Roy. Soc. N.S. Wales, vol. li. (1917), p. 238, and was first collected near Kalgoorlie, Western Australia. It is a small shrubby tree of nearly 3 m. high with spreading branches which start at the base of the trunk. The phyllodes are 25 to 75 cm. long and 1½ mm. wide, rigid, and spinescent. Flowers in short axillary racemes. Pods not seen.

A. *ramulosa*, W. V. Fitzg. O. 1268, 1269, 1274, 1489, B. 1333-5, 1492, 1495, 1502. New for South Australia. First described by W. V. Fitzgerald in Jour. W. Austr. Nat. Hist. Soc., No. 1, May, 1904, p. 15, from specimens collected at Lennonville, Western Australia. A shrub with branches spreading from the base. Phyllodes up to 17·5 cm. long and 1-1½ mm. wide, compressed terete. Veins many, very faint. Flowers yellow in cylindrical spikes of 12 mm. long, peduncle 12 mm. long. Pods 12·5 cm. long and 4·5 mm. wide, somewhat constricted between the seeds, with longitudinal narrow strips of white and green. Very like A. *linophylla*, W. V. F.

A. *Randelliana*, W. V. Fitz. O. 1294.

A. *salicina*, Lindl. O. 1488, 1493, I. 1248, B. 1313, 1315. I do not agree with Mr. Maiden's identification, but follow Mr. Black (Trans. Roy Soc. S. Austr., vol. xliv. (1920), p. 375, and pl. xxiii., figs. 6 to 11) in regarding this plant as A. *ligulata*, A. Cunn.

A. *tarculensis*, J. M. Black. T. 1497.

A. *tetragonophylla*, F. v. M. H. 1490, O. 1485, B. 1390.

*_Medicago denticulata_, Willd. O. 1629, B. 1379. Very little of this plant seen.

GERANIACEAE.

**Erodium Botrys*, Bert. O. 1612.
E. cygnorum, Nees. H 1526, T. 1191, 1744, K. 1821.

ZYGOPHYLLACEAE.

Tribulus terrestris, Linne. K. 1842.
Zygophyllum apiculatum, F. v. M. B. 1377.
Z. Billardieri, DC., var. *ammophilum*, J. M. Black O. 1591, B. 1376, T. 1187
Z. fruticulosum, DC. O. 1233, 1581, 1599, B. 1221, 1389, W. 1208, K. 1843.
Z. iodocarpum, F. v. M. H. 1253, 1509, K. 1844.
Z. ovatum, Ewart et White. H 1254, 1562, O. 1580, B. 1353, K. 1845. "Dis. W." These are new localities for this rare plant.

EUPHORBIACEAE.

Euphorbia Drummondii, Bois. H. 1613, O. 1572, T. 1782.
E. eremophila, Cunn. O. 1592, T. 1783, K. 1822.
Poranthera microphylla, Brong. B. 1325. "Dis. W."
Adriana Hookeri, (F. v. M.) Muell. Arg. O. 1305.

STACKHOUSIACEAE.

Stackhousia muricata, Lindl. O. 1594, B. 1355. There is a doubt about this identification, as *S. viminea*, Smith, apparently only differs in the corolla lobes being acute and not obtuse. "Dis. W."

SAPINDACEAE.

Heterodendron oleaefolium, Desf. O. 1590, T. 1787.
Dodonaea attenuata, Cunn. O. 1631, B. 1224, 1388.
D. microzyga, F. v. M. O. 1281, 1584, B.

MALVACEAE.

Sida calyxhymenia, J. Gay. T. 1728.
S. corrugata, Lindl., var. *orbicularis*, Benth. H. 1566, 1261, O. 1623, 1598, T. 1795.
S. corrugata, Lindl., var. *ovata*, Benth. W. 1398, T. 1719, 1733.
Sida intricata, F. v. M. K. 1837.
S. virgata, Hook. T. 1796.
Abutilon Mitchellii, Benth. T. 1759. "Dis. W."
A. otocarpum, F. v. M. O. 1622. "Dis. W."
A. oxycarpum, F. v. M. T. 1727, K. 1800. "Dis. W."
Lavatera plebeia, Sims. H. 1537, O. 1252, 1295.
**Malva parviflora*, L. T. 1797.

FRANKENIACEAE.

Frankenia pauciflora, DC. H 1510 "Dis. W"

F. serpyllifolia, Lindl. T. 1716, K 1851

THYMELAEACEAE.

Pimelea microcephala, R. Br. O. 1618, B 1369, T. 1792.

P. simplex, F. v. M O. 1619, B. 1349.

MYRTACEAE.

EUCALYPTUS SPECIES IDENTIFIED BY MR. J H MAIDEN, I.S.O., F.R.S., etc.

E. gracilis, F. v. M. O. 1477-8. ("With large fruits."—J. H. M.) "Dis. W."

E. incrassata, Labill. (?). I. 1340. ("Perhaps this species and close to the type."—J. H. M.)

E oleosa, F. v. M. O. 1270, 1473, 1483, I. 1481-2, B. 1337, 1346, 1361, 1372. No. 1372. ("This seems a very interesting form."—J. H. M.) Remarkable for its prostrate trunks, horizontal branches, and narrow grey glaucous leaves (pl. xli., fig. 1).

E. pyriformis, Turcz. O. 1310, with large fruits 5·6 cm. across, and O. 1484, with smaller fruits 3·7 cm. across.

E. transcontinentalis, J. H. Maiden. O 1288, 1292, 1371, 1373, 1475-6, B. 1344.

E. uncinata, Turcz. (?). O. 1299. ("Probably a form." —J. H M.)

E., sp. I. 1480. Mr. Maiden advises that he is making a new species of this plant.

Melaleuca hakeoides, F. v. M. I. 1245. "Dis. W."

M. parviflora, Lindl. O. 1304.

Thryptomene Elliottii, F. v. M. B. 1218, 1312.

Leptospermum laevigatum, F. v. M , var. *minus*, F. v. M. O. 1278.

UMBELLIFERAE.

Uldinia mercurialis, J. M. Black. O. 1267. Mr. Black is describing this new genus in these Transactions this year. I only saw this plant at Ooldea, after which it is named. Remarkable for the horizontal barbed wings to the fruit.

Didiscus glaucifolius, F. v. M. B. 1314, 1347. "Dis. W."

Daucus glochidiatus, (Labill.) Fisch. H. 1560, O. 1610, K. 1817. *(D. brachiatus*, Sieb.)

PRIMULACEAE.

*_Anagallis arvensis_, L. O. 1600, B. 1356.

ASCLEPIADACEAE.

Marsdenia Leichardtiana, F. v. M. O. 1601. "Dis. W."

CONVOLVULACEAE.

Convolvulus erubescens, Sims. H. 1528.

BORRAGINACEAE.

Lappula concava, F. v. M. O. 1307, T. 1789.

*_Lithospermum arvense_, L. O. 1632.

*_Echium plantagineum_, L. B. 1378.

LABIATAE.

Westringia Dampieri, R. Br., var. *rigida*, J. M. Black. O. 1630, B. 1375.

SOLANACEAE.

Solanum coactiliferum, J. M. Black. I. 1248, B. 1231, 1327.

S. ellipticum, R. Br. O. 1624, T. 1794, K. 1838.

S. orbiculatum, Dunal. B. 1359.

Anthotroche truncata, E. H. Ising. O. 1297, B. 1374. This new species is most rare; only two plants of it were seen. For description see p. 605 and pls. xxxviii. and xxxix., fig. 1.

Nicotiana suaveolens, Lehm. H. 1559, O. 1586a, B. 1322.

Lycium australe, F. v. M. T. 1791.

Duboisia Hopwoodii, F. v. M. B. 1343.

MYOPORACEAE.

Myoporum platycarpum, R. Br. W. 1215, O.

Eremophila alternifolia, R. Br. O. 1242, 1530, 1533a, 1579, B. 1710, T. 1402, K. 1820. No. 1530 is a shrub 2 metres in height and was remarkable for the variation in the colour of the flowers. On the same bush some flowers were wholly pink or reddish, others were partly pink and partly white, while others were all white.

E. Duttonii, F. v. M. T. 1406, 1779.

E. Gibsonii, F. v. M. O. 1265, 1308. "Dis. W."

E. glabra, (R. Br.) Ostenf. B. 1321, 1366, 1704, 1711, T. 1415. (*E. Brownii*, F. v. M., is a synonym.)

E. latifolia, F. v. M. O. 1587, T. 1741, K. 1819.

E. Latrobei, F. v. M. H. 1291, O. 1234a, T. 1780, K. 1826.

E. Latrobei, F. v. M., var. *Tietkensii*, Tate. O. 1234, 1243.

E. maculata, F. v. M. H. 1251, 1540, O. 1611.

E. Paisleyi, F. v. M. T. 1412.

E. rotundifolia, F. v. M. T. 1403.

E. scoparia, F. v. M. B. 1336, T. 1781.

PLANTAGINACEAE.

Plantago varia, R. Br. H. 1522, T. 1197.

RUBIACEAE.

Pomax umbellata, Sol. O. 1586.

CUCURBITACEAE.

**Cucumis myriocarpus*, Naud. B. 1392.

CAMPANULACEAE.

Wahlenbergia gracilis, DC. B. 1320.

GOODENIACEAE.

Velleia paradoxa, R. Br. O. 1615. The calyx consists of one ovate toothed sepal 10 mm. long and four shorter lanceolate entire sepals 7-8 mm. long. "Dis. W."

Goodenia pinnatifida, Schlect. H. 1255, 1551, O. 1616, B. 1362, T. 1745.

G. pusilliflora, F. v. M. T. 1405, K. 1827.

Scaevola spinescens, R. Br. O. 1277, 1597, B. 1219, 1370.

Calogyne Berardiana, F. v. M. T. 1418, 1736. "Dis. W."

COMPOSITAE.

Olearia Muelleri, Benth. O. 1617, B. 1348. (Synonym, *Aster Muelleri*, F. v. M.)

O. subspicata, Benth. O. 1266, B. 1381. (Synonym, *Aster Mitchellii*, F. v. M.) "Dis. W."

Vittadinia australis, A. Rich. H. 1525.

V. scabra, DC. O. 1691, B. 1342. "Dis. W."

Podocoma nana, Ewart et White. H. 1570, K. 1801. This rare plant has only been previously recorded from Glen Ferdinand, Everard Range, Mount Lyndhurst, and Torrens Plain (*vide* J. M. Black in these Transactions, vol. xxxix., 1915, p. 839). "Dis. W."

Minuria Cunninghami, Benth. H. 1573. "Dis. W."

M. leptophyla, DC. H. 1514, O. 1635, K. 1802.

Calotis cymbacantha, F. v. M. W. 1211, 1397, T. 1199, 1754.

C. erinacea, Steetz. O. 1693.

C. hispidula, F. v. M. H. 1523, B. 1391, T. 1770.

C. multicaulis, (Turcz.) J. M. Black. T. 1419.

C. multicaulis, (Turcz.) J. M. Black, nov. var. *breviradiata*. *Variat ligulis radii brevissimis, disco achaenii glabro absque apice pubescente, ciliis alarum sursum prominenter lobatarum simplicibus, pappi aristis sine barbellis reflexis, foliis inferioribus angustioribus et acutius dentatis.* H. 1552. Differs in the ligule of the ray flowers being very short, in the achenes being almost glabrous except for the pubescence at the summit, the hairs on the wing-margin simple, the wings prominently lobed at the top, and the awns without reflexed barbs, the lower leaves narrower and more sharply toothed.

Brachycome ciliaris, (Labill.) Less. O. 1309, 1583, B 1709, W. 1400, T. 1768, K. 1811.

B. ciliaris, (Labill.) Less., var. *glandulosa*, Benth. O. 1237.

B. Muelleri, Sond. W. 1205, 1396, T. 1421. "Dis. W."

B. pachyptera, Turcz. T. 1747, K. 1815.

**Centaurea militensis*, L. K. 1813.

Cratistylis conocephala, S. Le Moore. O. 1274, T. 1755.

Elachanthus pusillus, F. v. M. H. 1527, K. 1818.

Isoetopsis graminifolia, Turcz. H. 1524, K. 1825. "Dis. W."

Myriocephalus Stuartii, Benth. O. 1306, T. 1193, 1713.

Siloxerus brachypappus, (F. v. M.) comb. nov. H. 1529, O. 1699. As *Siloxerus*, Labill., is the earlier name (1806) it must replace *Angianthus*, R. Br. (1810). Mr. J. M. Black drew attention to this in his "Flora of South Australia" (1922), p. 6.

S. pusillus, (Benth.) comb. nov. O. 1240, B. 1323.

Gnephosis cyathopappa, Benth. T. 1765, K. 1853.

G. skirrophora, Benth. H. 1518, 1553, O. 1695, K. 1852.

Gnaphalodes uliginosum, A. Gray. O. 1290, 1585, B. 1358, T. 1784.

Craspedia pleiocephala, F. v. M. W. 1212, T. 1194, 1712, 1758, K. 1816.

Eriochlamys Behrii, Sond. et F. v. M. T. 1731.

Toxanthus Muelleri, Benth. B. 1324. "Dis. W."

Rutidosis helichrysoides, DC. K. 1847.

Millotia Kempei, F. v. M., var. *Helmsii*, F. v. M. et Tate O. 1576.

M. tenuifolia, Cassini. T. 1715.

Ixiolaena leptolepis, Benth. K. 1849, 1850.

Podotheca angustifolia, Less. O. 1694.

Podolepis acuminata, R. Br. T. 1720. "Dis. W."

P. canescens, A. Cunn. H. 1558.

P. capillaris, (Steetz.) Diels. B. 1220, 1326, W. 1203, T. 1738.

Leptorhynchus tenuifolius, F. v. M. O. 1696. "Dis. W."

L. tetrachaetus, (Schlect.) J. M. Black, var. *penicillatus*, J. M. Black. K. 1848.

Helichrysum ambiguum, Turcz. T. 1773, 1734. "Dis. W."

H. apiculatum, DC. O. 1300.

H. Lawrencella, F. v. M. O. 1582, B. 1223, 1225.

H. Lawrencella, F. v. M., var. *Davenportii*, Benth. T. 1786.

H. lucidum, Henck. B. 1352.

H. Mellorianum, J. M. Black. I. 1250.

Waitzia acuminata, Steetz. O. 1596, B. 1703.

Helipterum Charsleyae, F. v. M. K. 1804. "Dis. W."

H. Fitzgibbonii, F. v. M. T. 1409.

H. floribundum, DC. H. 1538, O. 1595, B. 1316, 1363, W. 1210, T. 1420, K. 1823.

H Humboldtianum, (Gaud.) DC. O. 1692, T. 1401.

H. Jessenii, F. v. M. K. 1803.

H. moschatum, Benth. T. 1198, 1410, W. 1399.

H. pterochaetum, Benth. T. 1750.

H. pygmaeum, Benth. K. 1828.

H. roseum, (Hook.) Benth., var. *patens*, (Ewart) J M. Black. W. 1206.

H. stipitatum, F. v. M. K. 1854. "Dis. W."

H. strictum, Benth. H. 1519, K. 1824.

H. tenellum, Turcz. H. 1568.

H. Tietkensii, F. v. M. O. 1633, B. 1350.

Senecio brachyglossus, F. v. M. H. 1571, O. 1634.

S. Gregorii, F. v. M. O. 1621, W. 1209, T. 1188.

**Cryptostemma calendulaceum*, R. Br. O. 1296.

Cephalipterum Drummondii, A. Gray. H. 1535, T. 1730, 1735.

VII. A New Solanaceous Plant,

Anthotroche truncata, n. sp.

Pls. xxxviii. and xxxix., fig. 1.

Frutex bimetralis pilis brevissimis plumosis divaricatis dense obtectis, foliis oblongis vel ovatis 5-10 mm. longis obtusis incanis breviter petiolatis, nervo medio prominente, floribus subsessilibus odoratis, calyce tubulato vix 2 mm. longo lobis ejus deltoideis brevissimis, corollâ albâ extra tomentosâ 3 striis longitudinalibus signatâ intus glabra lobis ejus late oblongis patentibus tubum subaequantibus, filamentis basi dilatatis et pilosis, ovario parce stellato-piloso.

Ooldea, East-West Railway Line, September 15, 1920, and Barton, in the same district, September 19, 1920.

A handsome shrub of 2 metres high, hoary. *Branches* round, hoary, with a fine tomentum wearing off in age, divaricate. *Leaves* 5-10 mm. long and 3-5 mm. wide, broad oblong to ovate, sometimes broad at base, entire, obtuse, hoary, with a very fine down of plumose hairs, midrib above and below and often a few lateral veins, prominent, scattered, or in clusters of 2 or 3, petiole very short. *Flowers* 1 to 3 in the leaf clusters, almost sessile, sweet-smelling. *Calyx* tubular, 1·5 mm. long, investiture similar to the leaves; *lobes* very short, obtuse triangular. *Corolla* white with three fine reddish short longitudinal lines inside, tomentose outside,' except almost smooth near the base, glabrous inside; lobes oblong, as long as the tube, spreading. *Stamens* 5, hardly exsert, filaments dilated and pilose at the base. *Ovary* with a few stellate hairs; *ovules* 2 to 3 in each cell, only one appears to develop and is finely tuberculate.

The new species is nearest to *A. Blackii*, F. v. M., but differs from this and all other species of this genus in the truncate calyx, the tomentose clothing, and rotate corolla.

DESCRIPTION OF PLATES.

PLATE XXXVIII.

Anthotroche truncata, n. sp. 1, Flower, viewed near the top; 2, flower, side view, showing calyx; 3, stamen, showing dilated pilose filament.

PLATE XXXIX.

Fig. 1. A new solanaceous plant (*Anthotroche truncata*, n. sp.) growing on a sandhill at Ooldea showing habit.

Fig. 2. Vegetation on a sand ridge at Ooldea showing *Eucalyptus transcontinentalis*, *Eremophila alternifolia*, *Olearia Muelleri*, *Triodia irritans*, and *Westringia Dampieri*.

PLATE XL.

Fig. 1. Nullarbor Plain at Hughes showing the open formation of bluebush (*Kochia sedifolia*) and saltbush (*Atriplex vesicarium*).

Fig. 2. At Ooldea Soak showing a carpet of *Myriocephalus Stuartii* with *Leptospermum laevigatum*, var. *minus*, on the right.

PLATE XLI.

Fig. 1. *Eucalyptus oleosa* at Barton with prostrate trunks.

Fig. 2. Barton from a sand ridge with *Thryptomene Elliottii* in the foreground, *Casuarina lepidophloia* and *Eucalyptus* below.

PLATE XLII.

Fig. 1. Looking north of Tarcoola showing the stony, undulating nature of the country. *Acacia tarculensis* and *Trichinium incanum* in the foreground.

Fig. 2. On the flats at Kingoonya. *Minuria leptophylla* in the foreground with trees of *Acacia Loderi* and shrubs of *Kochia sedifolia* in the middle distance.

The photographs were taken by myself.

MISCELLANEA.

Note on *Diastoma melanioides,* Reeve *(Mesalia).*

By Sir Joseph Verco, M.D. (Lond.), F.R.C.S. (Eng.).

Diastoma melanioides, Reeve.

Mesalia melanioides, Reeve, Conch. Icon., vol. v., pl. i., f. 3. Hab. (?) E. A. Smith, Ann. and Mag. Nat. Hist., Ser. 8, vol. xv., 1915, p. 370.

Mesalia exilis, Sowerby, Ann. and Mag. Nat. Hist., vol. xii., p. 236, pl. iii., fig. 9, W. Austr.

This shell was dredged by me in 1895 in 15 fathoms off Thistle Island, at the entrance to Spencer Gulf, with two smaller examples, and measured 42 mm. in length and 11·25 mm. in breadth. A dead shell was found on the Thistle Island beach. Off the Banks Group, in Spencer Gulf, in 12 fathoms, one small fresh example was dredged and one of medium size, dead. Later four specimens were taken on St. Francis Island beach, the largest of which, in perfect condition, was 41 mm. long and 12·5 mm. wide. In Petrel Bay, on the north of the island, in 15-20 fathoms, five very small dead specimens were dredged, and in 6 fathoms three tips. In 1911, at Esperance Bay, on the south coast of Western Australia, six full-grown beach specimens were obtained measuring up to 42·25 mm. long by 12·75 mm. wide. Shortly afterwards one of the latter was given to Mr. G. B. Sowerby when on a visit to Australia, as an example of *M. melanioides*, Rve., from Esperance, and a little while after this a reprint was received from him containing the publication of his *M. exilis*. When reminded of the circumstances under which he obtained it, he explained that he had failed to make a note of them at the time and they had slipped his memory, and without doubt his name was a synonym of *M. melanioides*, Rve. Its type locality is Esperance Bay.

The whorls in some examples are nearly flat and sloping, in others slightly convex; with a finely canaliculate suture, and with a shallow spiral groove about one-fifth the width of the whorl below the suture, which consequently seems somewhat marginal or adpressed. The numerous broad rounded axial costae are very valid in the upper whorls, where many of them are variceal, and these may form in some examples three vertical lines of varices, each just in front of that above; in other examples they are quite irregular. The varices disappear in the later whorls, and the axial costae also gradually fade out. The spiral lirae (with two to five intervening striae), about six in the spire whorls and twice as many in the body whorl, retain their validity. The thickly-glazed inner lip gives the impression that the callus of the posterior half has been first laid down over a circular area, and the anterior half laid down upon this over an area with a shorter radius, so that the edges of the areas meet each other at a wide angle, and the edge of the anterior circular area is continued into the aperture as a raised curved plait or carination. Its lower edge curves round anteriorly, and forms with the basal lip a shallow wide sinus with a slightly everted edge. The protoconch consists of two smooth convex homostrophe whorls. The ornament is composed of squarish light-chestnut spots immediately below the suture, with smaller spots more or less distantly articulating the lirae, and sometimes also so disposed as to form curved axial narrow flames of dots.

It is very closely allied to the fossil *Diastoma provisi*, Tate, Journ. and Proc. Roy. Soc. N.S. Wales, vol. xxvii., 1893, p. 177, Miocene and Older Pliocene (now recognized as Older and Newer Pliocene). Tate diagnoses between the two. He also shifts both species from the genus *Mesalia* to *Diastoma*, Deshayes. He writes, "Cossman, to whom the fossil was sent under the above name" *(Mesalia provisi)*, "informs me that it is a *Diastoma;* from him I have received examples of several species of *Diastoma* and *Mesalia* from the Parisian Eocene. This material permits me to affirm that *M. provisi*, Mihi, and *M. melanioides*, Rve., are congeneric with *D. costellatum*, Lamarck; whilst *Mesalia sulcata*, Lamarck (non *sulcata*, Gray = *brevialis*, Lamarck), is of a totally different type. *Diastoma* simulates *Mesalia*, but the latter has a sinuated outer lip, whilst the spiral carination of the columella of *Diastoma* is quite a different feature from the slight twist of the columella-margin of *Mesalia;* more over, *Diastoma* is more or less variced. *Mesalia* belongs to the Turritellidae; *Diastoma*, which has been located in at least two families, finds a resting place in Cerithiidae, it may be viewed as a Melania-like Cerithium."

E. A. Smith, in his review of the Genus *Mesalia*, *loc. cit.*, *supra*, does not refer to Tate's transfer of *M. melanioides*, Rve., to the Genus *Diastoma*, which, however, merits notice and acceptation or refutation.

Evening Meeting, September 14, 1922.

An Introduced Land Snail, *Helicella ventricosa*, Draparnaud.

Sir Joseph Verco showed a number of small snails collected in a garden at Woodville, at the end of last month. They were first noticed about five or six years ago in a bed of petunias, which they completely destroyed by ringbarking the stems rather than by consuming the leaves. They belong to the same species and are of the same size as some snails sent to the Adelaide Museum from Mount Gambier, which were identified as *Helicella (Cochlicella) ventricosa*, Draparnaud. Their habitat is the south of Europe and the north of Africa, the Canary Islands, and the Azores. They are found also in Bermuda as an introduction. They have evidently been brought by some means into South Australia, where they appear to be now widespread and numerous. A note of their appearance as a novelty near Mount Gambier is found in the last issue of the Records of the South Australian Museum, vol. ii., No. 2, April 3, 1922.

Jos. C. Verco.

Evening Meeting, May 11, 1922.

ABSTRACT OF PROCEEDINGS

OF THE

Royal Society of South Australia

(Incorporated)

FOR THE YEAR NOVEMBER 1, 1921, TO OCTOBER 31, 1922.

ORDINARY MEETING, NOVEMBER 10, 1921.

THE PRESIDENT (R. S. Rogers, M.A., M.D.) in the chair.

THE PRESIDENT referred to the approaching centenary of the Royal Society of New South Wales, and it was resolved - "That a suitable letter of congratulation be forwarded to that Society."

ELECTIONS.—Owen M. Moulden, M.B., B.S.; Melville Birks, M.B., B.S., L.R.C.P., F.R.C.S.; Professor T. Harvey Johnston, M.A., D.Sc.; and Oscar W. Tiegs, M.Sc., as Fellows.

PAPERS.—"The Pathological Morphology of *Cintractia spinificis*," by Prof. T. G. B. OSBORN, D.Sc., "Occurrence of Remains of Small Crustacea in the Proterozoic(?) or Lower Cambrian(?) Rocks of Reynella, near Adelaide," by Prof. SIR EDGEWORTH DAVID, D.Sc., F.R.S., etc.; "A New Species of *Lycosa* for South Australia," by R. H. Pulleine, M.B.

EXHIBITS.—Mr. L. KEITH WARD showed lantern slides of Typical Views of the Eucla Basin and Nullarbor Plain, with Maps descriptive of the topography, geology, rainfall, and artesian water supply of the district. Mr. A. M. LEA exhibited the three known blind beetles of South Australia, *Illaphanus stephensi* (Carabidae), *Rodwayia minuta*, Lea (Tricopterygidae), and *Halorhynchus caecus* (Curculionidae). Capt. S. A. WHITE showed botanical specimens from the North-western District of New South Wales. SIR DOUGLAS MAWSON showed calcareous deposits from a series of caves in the limestone near Reynella.

ORDINARY MEETING, APRIL 13, 1922.

THE PRESIDENT (R. S. Rogers, M.A., M.D.) in the chair.

THE PRESIDENT welcomed as a visitor Dr. McGillivray, President of the Broken Hill Ornithological Society. He also announced with deep regret the death of Mr. F. R. Zietz, who had joined the staff of the South Australian Museum more than thirty years ago, and was at the time of his death ornithologist to that institution. He was elected a Fellow of this Society in 1912, and had contributed important papers on the Wild Hybrids of Australian Ducks, and Australian Lacertilia; he had also taken an active part in the discussions, and been responsible for many interesting exhibits at the meetings.

ELECTIONS.—J. Sutton and Thos. Draper Campbell, B D.S., were elected Fellows.

PAPERS.—"Notes on Australian Polyplacophora, with descriptions of three New Species and two New Varieties," by EDWIN ASHBY, F.L.S., M.B.O.U.; "A New Isopod from Central Australia belonging to the Phreatoricidae," by CHAS. CHILTON, D.Sc., C.M.Z.S. (communicated by Prof. F. Wood Jones, M.R.C.S., D.Sc., etc.); "The Flora and Fauna of Nuyt's Archipelago and the Investigator Group, No. 1—Amphipoda and Isopoda," by CHAS. CHILTON, D.Sc., C.M.Z.S. (communicated by Prof. F. Wood Jones, M.R.C.S., D.Sc., etc.), "The External Characters of Pouch Embryos of Marsupials, No. 3—*Isoodon Barrowensis*," by Prof. F. WOOD JONES, M.R.C.S., D.Sc., etc.

RESOLVED—"That the types and co-types collected by Prof. F. Wood Jones during his exploration of Nuyt's Archipelago be presented to the South Australian Museum."

RESOLVED—"That a letter be sent to the Chairman of the S.A. Harbours Board expressing appreciation of the courtesy extended to the Professor by affording him facilities to travel in the Board's s.s. 'Victory.' "

EXHIBITS.—Mr. A. M. LEA exhibited a collection of bones taken from the pellets of the common owl, representing a year's food for one of these useful birds. It included bones of 1,407 mice, 143 rats, 5 young rabbits, 375 sparrows, 23 starlings, and a few other birds, frogs, and bats; also some insect remains. Some of the bones showed considerable sponge-like swellings, indicating serious disease. He also showed a collection of insects from North-west Australia, presented by Dr. Morgan. Also a root from Mr. L. Harnett, taken from the ground under an Adelaide building erected 62 years ago, and still perfectly sound. Prof. F. Wood Jones exhibited three maxillae of *Thylacoleo* and portions of maxillae and mandibles of *Thylacinus* which he had found in Buckalowie Cave, No. 2, near Carrieton. Capt. S. A. WHITE showed a large sheet of mycelium of a remarkable fungus resembling chamois leather, found between the layers of wood of a giant *Eucalyptus rostrata* felled at the Reedbeds, near Adelaide.

Ordinary Meeting, May 11, 1922.

The President (R. S. Rogers, M.A., M.D.) in the chair.

The Hon. Secretary stated that the Council had asked Prof. Sir William H. Bragg to represent the Society at the 150th Anniversary of L'Académie Royale de Belgique, and read a reply regretting his inability to be present on that occasion.

The Hon. Secretary read a letter from the National League for the Protection of Natural Monuments, Florence, asking the co-operation of the Fellows in the provision of illustrations of native animals for zoological handbooks to be issued by the League.

Papers.—"A Geological Traverse of the Flinders Range from the Parachilna Gorge to the Lake Frome Plains," by Prof. Walter Howchin, F.G.S.; and "The Parasites of Australian Birds," by Prof. J. Burton Cleland, M.D. In the absence of the author, and also, through illness, of Prof. F. Wood Jones, who was to have introduced it, the latter paper was taken as read.

Exhibits.—Sir Joseph C. Verco showed a number of small snails (*Helicella ventricosa*, Draparnaud) (*vide* Miscellanea). Mr. A. M. Lea exhibited a drawer of rove beetles (Staphylinidae), several of which have remarkable combs on the middle leg. One species lives on bush rats, another on the flying fox, and others in nests of ants. Mr. W. J. Kimber showed large fossil sharks' teeth from Port Willunga cliffs; polyzoic limestone and a cast of a large cowrie shell from Point Turton; and *Truncatilla scalarina*, associated with large deposits of sepia bones in raised beach at Minlacowie.

Ordinary Meeting, June 8, 1922.

The President (R. S. Rogers, M.A., M.D.) in the chair.

Nominations.—C. T. Madigan, B.A., B.Sc.; Guy A. Lendon, M.B., B.S., M.R.C.P.; and Alan H. Lendon were nominated as Fellows.

Papers.—"The Tertiary Brown Coal-bearing Beds of Moorlands," by Prof. Sir Douglas Mawson, D.Sc., B.E., and Frederick Chapman; "External Characters of Pouch Embryos of Marsupials, No. 4—*Pseudochirops dahli*," by Prof. F. Wood Jones, M.R.C.S., D.Sc., etc.; and "A New Species of *Puccinia*," by C. F. Johncock, Corr. Mem. (communicated by Prof. W. Howchin, F.G.S.).

Exhibits.—Prof. W. Howchin exhibited several highly-glaciated erratics obtained during his late expedition into Central Australia in company with Prof. Sir Edgeworth David under a grant from the Australian Association for the

Advancement of Science. The specimens were obtained from the tillite exposed at Yellow Cliff on the Finke River, and from a new locality in the Crown Point Hill Range in the same neighbourhood. Mr. A. M. **Lea** exhibited a common Queensland scorpion (*Hormurus caudicula*) obtained alive in Adelaide by Mr. A. Bottcher in some bananas from Queensland.

ORDINARY MEETING, JULY 13, 1922

The President (R. S. Rogers, M A., M.D.) in the chair.

Nominations.—Geoffrey Samuel, B.Sc., William Ham, F.R.E.S.; and R. L. T. Grant, M.B., B.S., M.R.C.P., as Fellows.

Elections.—C. T. Madigan, B.A., B.Sc.; G. A. Lendon, M.B., B.S., M.R.C.P.; and A. H. Lendon, as Fellows.

Papers.—"Contributions to the Orchidology of Australia and New Zealand," by R. S. **Rogers**, M A., M.D.; "The Physiography of the Meadows Valley, Mount Lofty Ranges," by E. O. **Teale**, D.Sc. (communicated by Prof. Walter Howchin, F.G.S.).

Exhibits.—Mr. A. M. **Lea** exhibited a drawer of insects showing remarkable differences in the sexes. Prof. J. B. **Cleland** exhibited a specimen of the rare puffball *Mytremyces fuscus*, Bert. This is a new record for South Australia, and was found on the shady side of a road cutting, at Mount Lofty, on July 1. The exhibitor has only personally met with this fungus once before, on a similar shady bank on the Cambewarra Mountains, near Noura, N.S.W. The plant has an erect dirt-coloured fenestrated stem, capped by a rounded receptacle showing projecting whitish (sometimes vermilion) teeth. In an early stage the receptacle is covered with a little cap, one of which was also exhibited, having been thrust off on to the ground. Dr. E. **Angas Johnson** showed two specimens of *Unio* from River Onkaparinga. Prof. F. **Wood Jones** showed two adult specimens of *Myrmecobius*, probably distinct races, one from Western Australia and one from South Australia. Mr. E. R. **Waite** showed a model, one-tenth natural size, of *Camarasaurus*, and a fossil femur of the same Dinosaur, found at Wyoming, U.S.A. The model was prepared under the direction of Prof. Henry Fairfield Osborne, Director of the American Museum of Natural History. Mr. R. L. **Jack** showed a geological model of Iron Knob and its vicinity.

ORDINARY MEETING, AUGUST 10, 1922.

The President (R. S. Rogers, M.A., M.D.) in the chair.

Elections.—R. L. T. Grant, M.B., B.S., M.R.C.P.; William Ham, F.R.E.S.; and Geoffrey Samuel, B.Sc., as Fellows.

Nominations.—Miss E. D. Nobes, B.Sc.; Herbert M. Hale; and Albert Geo. Charles, as Fellows.

The President reported that at the invitation of the Queensland Branch of the Royal Geographical Society the Council had appointed Prof F. Wood Jones to represent them upon a joint committee to consider the suggested exploration of the Great Barrier Reef, and Prof. Sir Douglas Mawson to represent the Society on the Council of the Australasian Association for the Advancement of Science at its meeting in Wellington, N.Z. Also that a letter had been received from Queensland asking for co-operation in urging the Government to take steps to prevent the extinction of the *Ceratodus*, and that the Council had endorsed the suggested action.

Papers.—"Some New Records of Fungi from South Australia, Part II., together with a description of a New Species of *Puccinia*," by Prof. T. G. Osborn, D.Sc., and Geoffrey Samuel, B.Sc.; "An Investigation of the Essential Oil obtained from *Eucalyptus cneorifolia*, DC.," by Philip A. Berry, B.Sc. (communicated by Prof. E. C. Rennie, D.Sc.); "The Flora and Fauna of Nuyt's Archipelago and the Investigator Group, Part 2—The Monodelphian Mammals," by Prof. F. Wood Jones, M.R.C.S., D.Sc., etc.; "The Flora and Fauna of Nuyt's Archipelago and the Investigator Group, Part 3—A Sketch of the Ecology of Franklin Island," by Prof. T. G. B. Osborn, D.Sc.

Ordinary Meeting, September 14, 1922.

The President (R. S. Rogers, M.A., M.D.) in the chair.

Elections.—Miss E. D. Nobes, B.Sc.; H. M. Hale; and A. G. Charles, as Fellows.

Papers.—"On the Striation of Voluntary Muscle Fibres in Double Spirals," by O. W. Tiegs, M.Sc.; "The Flora and Fauna of Nuyt's Archipelago and the Investigator Group, Part 4—Coleoptera," by Arthur M. Lea, F.E.S.; "Australian Lepidoptera of the Tribe *Geometrites*," by A. Jefferis Turner, M.D., F.E.S.; "Australian Coleoptera, Part III., by Albert H. Elston, F.E.S.; "Cylindro-Conical Stones from the Darling River and Cooper Creek," by R. H. Pulleine, M.B.

Exhibits.—Sir Joseph Verco showed some shells (*vide* Miscellanea); also 27 almonds in their shells taken from the crop of a game rooster which was found in convulsions. The crop was opened by the owner, a gardener, the almonds removed, and the wound sewn up, the fowl being found quite lively the next day. Mr. A. E. Edquist showed two samples of *Loranthus exocarpus*, one grown on an orange tree and one on a tugasaste. Capt. S. A. WHITE exhibited three birds taken during his recent transcontinental trip:—*Barnardius macgillivrayi* (Cloncurry parrot) and *Aprosmictus erythopturus* (Red-winged parrot), from North-west Queensland, and *Barnardius zonarius myrtae* (Mrs. Morgan's parrot), from the Northern Territory. Mr. A. M. LEA showed larvae of cockchafers from Nantawarra, where they were stated to be destroying from 50 to 75 per cent. of the crop on one farm by eating the roots.

ANNUAL MEETING, OCTOBER 19, 1922.

THE PRESIDENT (R. S. Rogers, M.A., M.D.) in the chair.

The ANNUAL REPORT and FINANCIAL STATEMENT were read and adopted.

The Field Naturalists' ANNUAL REPORT was read and adopted.

PRESIDENT'S ADDRESS.—The retiring President delivered an address, the subject of which was "A History of the Royal Society of South Australia, particularly in its relation to other Institutions in the State."

PRESIDENTIAL ADDRESS.

By R. S. ROGERS, M.A., M.D.

A History of the Society, particularly in its Relation to Other Institutions in the State.

An annual Presidential address has by no means been an established rule in this Society, and during the last forty-six years there have been no less than twenty-nine occasions on which it was omitted.

While it would seem unnecessary that your President should address you as a matter of duty every year, there would appear to be good reasons why the observance should not be allowed to fall wholly into abeyance. It is obviously a wise thing to make a halt in our proceedings now and then, in order that a retrospect may be made. Facts and events are but too easily forgotten, and occasional opportunity should be afforded to record them in their historical sequence.

As a Society we are no longer young; we have already reached our three score and ten, and are hastening towards that century which many of you will doubtless celebrate. For this reason I desire to direct your attention to some of the more salient points in our history, particularly in its relation to other institutions in the State.

1. PRELIMINARY.

It is hardly necessary to remind you that we are the immediate offspring of the Adelaide Philosophical Society, which became transmuted into the Royal Society by the simple device of changing its name and some of its laws, but which has otherwise led a continuous and unbroken existence for seventy years. There were, however, earlier organizations, more or less related to our predecessor in their objects and personnel, which may in a sense be regarded as end-products of their period. These were all ephemeral. They appeared upon their little stage, fulfilled in varying degree a useful purpose, then vanished into the limbo of history. They are even now, after a comparatively brief lapse of time, a little difficult to unearth; and when the preliminary spade-work is done, their aliases and their fusions and their recrudescences make identification in some instances rather perplexing.

2. Early Organizations and Precursors of the Adelaide Philosophical Society.

Not the least important of these precursors of the Philosophical Society was the South Australian Literary and Scientific Association, founded in London in August, 1834, just a fortnight after the Bill for the Establishment of the Colony had received Royal assent.

Owing to the good offices of Mr. Thomas Gill, we have in the Archives of the Public Library the first minute book of this Association. Among the signatories to the form of obligation the following names are of special interest:—Dr. John Brown, Thomas Gilbert, Robert Gouger, R. D. Hanson, G. S. Kingston, Osmond Gilles, Daniel Wakefield, John Morphett, J. W. Childers, Raikes Currie, C. G. Everard, R. Torrens, J. Hindmarsh, Chas. Mann, B. T. Finniss, and others. Some of these men subsequently became active members of the Philosophical Society.

The objects of the Association were: "The Cultivation and diffusion of useful knowledge throughout the Colony"; and as a means to this end, one of their earliest acts was the acquisition of a small but excellent library, containing books of travel and reference, likely to be of special service to a young community.

Sir Charles S. Napier, the hero of Scinde, was elected as President, and for more than a year numerous meetings were held at short intervals in London. Some of these were of a conversational character; at others addresses were delivered on scientific subjects, such as the geology and anthropology of Australia. In December, 1835, just prior to embarkation for the new Province, a committee was appointed for the ensuing year and the records abruptly ceased. The library was packed in the same chest as the Royal Charter, and ultimately arrived in Adelaide, after various misadventures, in a somewhat damaged condition.

According to a statement made by Charles Mann, the pressure of employment, incident upon the earlier stages of immigration, prevented any further meetings of the Association in the new Colony.

It so happened that in 1838, there became established at the "Rooms of the South Australian School Society," in this city, "The Adelaide Mechanics' Institution," under the presidency of James Hurtle Fisher, at that time Resident Commissioner and Registrar. The aims of this body were the delivery of evening lectures, together with the control of a reading room and circulating library of some 300 books. Unfortunately it did not receive the support it had anticipated, and in less than a year it was in dire difficulties, unable to meet its obligations, and consequently in danger of having its books sold by public auction. At this critical period of its history, the trustees of the South Australian Literary and Scientific Association came to its rescue with an offer of amalgamation. The offer was accepted. The latter association was dissolved and its library was handed over in trust to the new body, which now bore the cumbrous title of "The Adelaide Literary and Scientific Association and Mechanics' Institute."

But these were not healthy days for the survival of such societies, and in turn the new venture faded away, rather than dissolved. It finally became extinct in 1844. By some means, the books which had been brought from England, were deposited with Mr. Da Costa to cover a debt of £20, and were still in his hands when yet another organization appeared.

This was the "South Australian Subscription Library," which was founded in the year just mentioned. Charles Mann, in his evidence before the General Committee of the Adelaide Library and Mechanics' Institute some years later, says that he and some of his co-trustees of the early London association paid the debt due to Da Costa and presented the books to the South Australian Subscription Library, "of which they formed the nucleus." In order that they might not be subject to any risk consequent upon a dissolution of the society, it was stipulated that in such an event they should become public property and be vested in three of the principal officers of the Colony.

The Adelaide Subscription Library was modelled on the lines of some of the best English institutions. Its subscription was high and its membership exclusive. It was unsuitable for a young colony where the population was small and the number of leisured intellectual people very few. As might have been expected, it soon began to decline.

In 1847 a rival arose, with a freer and more democratic constitution. The latter was known as the Mechanics' Institute, and appears to have had no connection with the former society which bore the same name.

The rivalry which existed between these two bodies was not of a healthy character, and did not tend to promote the success of either. It meant the support by a not very wealthy community of two institutions instead of one, and it soon became evident, that unless they could in some way combine their efforts and resources, both were doomed.

The Mechanics' Institute was the first to make overtures for a coalition, but these were coldly received by its rival. When, however, these overtures were backed by a promise of two substantial donations of £100 each from wealthy citizens, the proposal was more favourably considered, and, after much parleying, a junction was effected.

Thus was born, in 1848, "The South Australian Library and Mechanics' Institute." Reorganization, however, did not prove a panacea for the troubles which had so constantly dogged the steps of these various institutions. The amalgamated society showed but short-lived virility. It shifted from Peacock's Buildings, in Hindley Street, to a more central position in Green's Exchange, a site now occupied by the Australian Mutual Provident Society. In a very few years, owing to mismanagement and other causes, it was in financial difficulties. Contrary to expectations, however, it did not expire from inanition, as its predecessors had done, but suddenly gave birth to a lusty infant, which was to become chief partner in a body corporate, with the Philosophical Society as a junior member. This influential partnership lasted for a quarter of a century, when it was dissolved by the Public Library Act of 1884.

It is hardly necessary to inform you that this infant was the South Australian Institute.

3. THE ADELAIDE PHILOSOPHICAL SOCIETY.

(a) Historical Records.

The early struggles and activities of the Adelaide Philosophical Society are recorded in its Annual Reports, in the newspapers of the day, and in certain documents recently transferred by our Society to the Archives Department of the Public Library.

These documents comprise:—

- A.—The first minute book of the Adelaide Philosophical Society (1853).
- B.—Papers read and deposited with the Society from 1853.
- C.—Correspondence relating to a proposed Exploring Expedition from Fowler's Bay into the Interior (1855).
- D.—Miscellaneous papers and newspaper cuttings.
- E.—Papers relating to its incorporation with the S.A. Institute (1856-71).
- F.—Papers relating to the proposed division of the Society into Sections (1859).
- G.—Correspondence between the Adelaide Philosophical Society and the S.A. Institute on the one hand; and between the Royal Society and Public Library Board on the other.
- H.—Correspondence relating to the adoption of the title "Royal Society of South Australia" (1879-81).

The minute books from September, 1853, to the end of 1872, do not appear to have been preserved, but reports of the monthly meetings appear with a fair degree of regularity in the daily papers of that period.

The first Annual Report was read on January 30, 1854. It consists of four pages (parliamentary size) and contains the personnel of the Council and list of members, together with a copy of Laws of the Society and a digest of its Transactions and Proceedings. Similar reports continued to appear until 1858, when the month for the Annual Meeting was changed to July. No further printed reports were issued for some years after this, although they were evidently read and fully published in the newspapers.

Annual meetings were again changed to August for 1859 and 1860, and to October from 1861-3. Thereafter the year has apparently always closed at the end of September.

Printed reports (in quarto form) re-appeared in 1865, but again ceased in 1872.

A brief manuscript report for 1876-7 is to be found among the miscellaneous papers. From this date onwards they have been issued annually in their present form.

It should also be mentioned, that brief abstracts of the Annual Reports of the Society, from 1863-84, are to be found as appendices to the Annual Reports of the S.A. Institute.

(b) Inception of the Society.

The Society was founded on January 10, 1853.

On the afternoon of that date five prominent citizens of Adelaide met at the house of Mr. J. L. Young, in Stephen's Place, hardly a stone's throw from this building, for the purpose of establishing a Society "for the discussion of all subjects connected with literature and arts."

John Howard Clark occupied the chair at this preliminary meeting, and there were also present: Messrs. J. L. Young, C. G. Feinaigle, — Jones, and Dr. William Gosse.

Three of these names, *viz.*, that of J. H. Clark, a former editor of *The Register;* J. L. Young, the Principal of a well-known scholastic institution; and Dr. Gosse are still well remembered.

Mr. Jones apparently did not attend any further meetings that year, and his name does not appear on the list of members published in 1854. His identity is probably lost in the mists of time.

The fifth man, (1)Charles Gregory Feinaigle, was the originator of the scheme, and as such claims our consideration. His residence in South Australia was of short duration, and consequently he is comparatively unknown in this State. I am indebted for much of the following information concerning him to the courtesy of the librarians of the Melbourne and Mitchell Libraries:—

He was born in 1818, and graduated B.A., Trinity College, Dublin, in 1839. The date of his arrival in Adelaide is uncertain, but his name appears for the first time in the South Australian Almanac for 1851, as Headmaster of the High School, on the S.A Company's premises, North Terrace. This was a proprietary school, apparently just founded, with shares at £5 each. J. L. Young arrived in October, 1850, and his first position was that of Assistant-master in the High School. In 1851 both these young men were seized with the gold fever and went to the Victorian diggings. After an absence of several months Young returned, and was induced to open a school in Ebenezer Place, off Rundle Street East, but the movements of Feinaigle are not chronicled. From the facts already related, it is evident that he returned to Adelaide before the beginning of January, 1853. He occupied the chair, and read a paper on "The Mathematical Theory of Musical Harmony on April 25 of that year, and is mentioned in the First Annual Report, January, 1854, as "being now absent from the colony." For many years thereafter his name appears as a corresponding member, with a Melbourne address. As a matter of fact, he entered the Victorian Public Service as a clerk in January, 1854, and subsequently filled various positions in the Census, Police, and Mines Departments. While still in Melbourne, he contributed a paper to the Society in September, 1863. He retired from the Victorian Service on a pension in 1877, and died at his residence, South Yarra, after a long illness, on March 16, 1880.

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(1) J. H. Clark in report of meeting of Philos. Society in *The Register*, 23/9/63.

Three preliminary meetings were held at Stephens Place, and at these rules were drawn up for the government of the Society, and the annual subscription fixed at a guinea. Visitors were to be admitted to the meetings on introduction by a member, and they were allowed to take part in the discussions, a privilege not infrequently exercised. It was decided that the election of members was to be by ballot, one negative vote excluding. It is worthy of note, that one candidate was so excluded, during the first few months of the Society's existence.

In addition to such routine business, the roll of membership was greatly increased, and it is safe to say that the young Society already included within its ranks the best literary and scientific talent to be found in the city. Some of its members were men of undoubted ability and marked originality of character. A list of foundation members will be found in the Appendix, but it may not be out of place to refer more particularly to a few of them.

Edward Davy, a versatile doctor, had a most extraordinary career. While still in England, he had already been recognized as a formidable rival to such men as Cooke and Wheatstone, in the new field of telegraphy. Not only was he an inventive genius in this science, but in many other branches as well. Quite suddenly, when his discoveries seemed likely to lead to wealth and eminence, he appeared to lose interest, and sailed for Australia as surgeon to an emigrant ship. Reaching the new colony in 1839, he abandoned his profession and engaged in pastoral pursuits. Then followed a career of journalism, and for about three years he was editor of *The Adelaide Examiner*. Later still he became manager of the Yatala Copper Smelting Works. He retained this position for a few years, and then relinquished it in favour of the control of the Government Assay Office, where for the first time in Australia gold tokens were coined. Owing to his success in this department, he was lured to a similar appointment in Melbourne at a salary of £1,500 per annum. Owing, however, to necessary retrenchments, his new appointment was of short duration, and in eighteen months he was once more a farmer, this time coupled with the practice of his profession as a sideshow. Finding that farming did not pay, he turned his attention to medicine and municipal affairs in the sister colony of Victoria, and ultimately became mayor of a country town and a Justice of the Peace. He appears to have been an active member of the young Society, and as a Corresponding Member retained his interest for many years after leaving Adelaide.

Then there was Charles Mann, a former member of the South Australian Literary and Scientific Association, and at the period under review Crown Solicitor and a stalwart intellectual in the city. On account of his influence and literary tastes, he was an important accession to their ranks. He became their first Honorary Treasurer.

J. L. Young never held office, but his intimate association with the infancy of the Society makes the picture incomplete without him. For this reason, and also for the fact that we are partly indebted to him for that highly-finished product of his art, our immediate Past-President, I would like to see his portrait included in our family album. Owing to the good offices of a former pupil (Mr. F. W. Bullock), this portrait is forthcoming if the Council will accept it. Unfortunately, owing to the lack of book-space, the walls of this room do not adapt themselves to the hanging of portraits, otherwise it would appear desirable to take immediate steps to secure as many photographs of foundation members for this purpose as possible.

Young and Clark had been fellow-students at King's College, London, where the former was educated as a professional engineer. They were the same age, 23, when the preliminary meeting of the Society took place.

John Howard Clark was undoubtedly the backbone of the Society and the most outstanding figure in its activities for upwards of twenty years. He was its first Hon. Secretary, a position which he held for nine years. Thereafter he became Hon. Treasurer, an office for which he was admirably adapted by reason of his early training as an accountant. His connection with *The Register* from 1865 onwards proved of the greatest service to the Society in the troublous years of financial depression, when the strictest economy had to be exercised in regard to printing.

Another live wire among these pioneer members was W. W. R. Whitridge, journalist and pastoralist. He was editor of *The Austral Examiner* and subsequently of *The Register*. He early advocated the value of publicity, and the admission of representatives of the Press to the monthly meetings—advice which the Society adopted with much profit to itself. He was a brilliant literary man, but unfortunately died at the early age of 36.

The first ordinary meeting of the fully constituted Society was held on February 21, 1853, at the new City Council Chamber, then situated at the back of the present Town Hall. No rental was charged for the use of this room, and afternoon meetings were held there every month, until the close of 1858, when a change seems to have been made to White's Commercial Rooms, where the Majestic Theatre now stands. Its work began to attract immediate attention, and resulted in the addition of such conspicuous men as the Governor of the State, the Chief Justice (Sir Richard Hanson), Sir George Strickland Kingston, Sir Arthur Freeling, Dr. Andrew Garran (another editor of *The Register* and subsequently editor of the *Sydney Morning Herald*). The Press was well represented, and as a consequence the meetings received full and eulogistic reports in the daily newspapers.

One of the earliest matters to receive consideration was the formation of a Museum to illustrate the natural history of the colony; but the difficulty which prevented the idea crystallizing into practical form, was the necessity of procuring suitable premises, and the high cost of rentals. It was suggested that the Government might possibly be willing to assign a room in one of the public departments for this purpose, and the matter was accordingly left in the hands of Mr. B. H. Babbage to privately sound the Minister before making formal application. Later on it was ascertained that the Mechanics' Institute was contemplating a similar application, and although the matter was left in abeyance by the Society for the time being, it was never lost sight of, and frequently claimed their consideration at subsequent meetings.

Towards the close of 1853 the rules which had been in use since the founding of the Society were reconsidered and a series of "laws" substituted. The chief alterations had to do with the formation of a Council or Executive body, Hitherto a Chairman had been elected to conduct the business of each meeting. Under the new laws, the officers consisted of a President, two Vice-Presidents, a Treasurer, and a Secretary. They were elected annually and together constituted the Council. For a great many years after this, it became the custom to elect the Governor of the Province to fill the chief position on the Council. There was only one exception to this rule, when, owing to the transfer of His Excellency Sir H. E. F. Young to Tasmania, B. H. Babbage was elected to the Presidency.

At the end of the first year the membership stood at 35. The young Society was now planted firmly on its feet, and in a position to state its objects and aspirations with a considerable degree of precision. They were twofold. (1)

"It was sought to afford an agreeable medium of intercommunication to those whose tastes led them in pursuit of similar studies"; and (2) to "present a means of illustrating and recording the many interesting phenomena, which are altogether peculiar to this country, and which it is feared will otherwise be lost in a very few years' time, to the records of science." In the papers contributed during that year, the second of these objects had not been overlooked, and at least two of them dealt exclusively with matters of local interest, that by Mr. M. Moorhouse on "The Structure of the Aboriginal Dialects" being of outstanding importance.

The activities of the Society were not confined to the reading of papers, but extended to other matters affecting the public weal.

With such members as B. H. Babbage, Charles Bonney, and A. H. Freeling in their ranks, it is not surprising that a spirited interest should be aroused in exploration of the Province, important to them not only from an economic but also from a philosophic point of view. This was particularly the case in regard to the North-west Interior, which, like so many other parts of the continent, was then a *terra incognita*. Rumours of various kinds had filtered through to them from native and other sources, which led them to believe that this vast tract of country contained not only areas of pastoral importance, but also material of a scientific nature which intimately concerned them as a Society. In 1854 a sum of £3,000 was passed by the Legislature for the purpose of exploring this portion of the colony, but owing to the difficulty of securing the services of a suitable leader, the sum still remained as an unexpended balance at the end of the financial year.

In 1855 the Society appointed a Special Committee to memoralize the Governor upon the urgency and importance of this enterprise, and also to collect such information as might tend to facilitate the organization and assist the operations of an exploring party.

In addressing His Excellency Sir R. G. MacDonnell, the memoralists pointed out, that "there exists at present a large and increasing demand for additional accommodation for the flocks and herds of the stockholders, occasioned partly by the rapid increase in the numbers of sheep and cattle themselves, and partly by the amount of land which has recently been taken up for agricultural purposes. That the very limited extent of the known and settled districts of the colony, coupled with the fact that the North-west Interior comprises an area of at least 150,000 square miles, offers reasonable ground for hoping that a knowledge of the character of this vast and unexplored region would afford ample room for the extension of pastoral pursuits. That without pausing to dwell upon the desirability and importance of extending the limits of geographical science, the further consideration and knowledge of this extensive tract of country, may be reasonably expected to lead in an important degree to a greater development of our mineral resources, and thus open up new fields of enterprise and additional sources of wealth to our colonists." To the memorial His Excellency gave a most sympathetic reply and requested the Committee to submit to him a plan for such an expedition, together with an estimate of its probable cost; also to ascertain whether a suitable leader could be found to undertake the command of the party.

A sheaf of correspondence between the Committee and such experienced bushmen as Dr. J. H. Browne, J. McKinlay, E. B. Scott (a friend of Eyre), Price Maurice, and many others, shows that this request was promptly obeyed. As a result, we see the plan of the expedition outlined in a letter from the Committee to John Williams, of Black Rock, who had written, that if possible he would "be happy to undertake the business, notwithstanding the present discouraging aspect of affairs in that quarter." The plan was that an expedition, consisting of about eight men, should be landed at Fowler's Bay, make its way if possible due north to the north-east corner of the Province, and return in a south-easterly line to the head of Spencer Gulf. In the letter they asked permission from Mr. Williams to mention his name to His Excellency as a suitable leader.

Despite the energy displayed by the Committee, this particular expedition did not eventuate, and the vote of £3,000 was appropriated for other purposes It is significant, however, that the plan of Hack's Expedition in 1857 was almost identical with that advocated by the Society two years previously, except that it started from Streaky Bay. It is, therefore, probable that the Government was not altogether uninfluenced by the recommendation of the Committee.

Hack's effort was followed, in 1858, by another Government Expedition into the interior, under the leadership of a former President of the Society, B. Herschel Babbage.

Another matter of a public nature, which claimed the early attention of the Society, was the establishment of a South Australian Institute, which should be erected and maintained by the Government, and should have for its object the fostering of the arts, sciences, literature, and philosophy. It was thought that one of the functions of such an institution would be the establishment of a Natural History Museum, and that it would also provide accommodation for such societies as might become incorporated with it. The Philosophical Society, during the first few years of its existence, was dependent on the goodwill of the City Council for a room in which to hold its meetings, and it eagerly desired something in the nature of a permanent home.

The only existing institution having a somewhat similar scope was the almost moribund South Australian Library and Mechanics' Institute. It was evident that this organization could not long survive by its own unaided efforts, and it was already, in 1853, seeking Government support to avoid extinction. It seemed probable that its purpose could be most satisfactorily achieved by its conversion into such an Institute as had been dreamed of by our Society. Consequently the two organizations joined issue in their attempts to secure this desirable object, but it was chiefly due to the energy displayed by the Society's representatives, John Howard Clark and B. H Babbage, that their efforts were ultimately crowned with success

In 1856 the South Australian Institutes Act was passed, and within a month the Institute began its career of usefulness It was administered by a Board of six, three of whom were appointed by the Governor and three by the Societies which it had power to incorporate

The Act provided that a sum of not less than £500 should be made available for maintenance, and a short amending Act enabled the Board to make advances of money to Incorporated Societies. No time was lost by the Society in making its application for incorporation, but although a sympathetic reply was received, it was nevertheless pointed out, that however desirous the Board of Governors might be to effect such incorporation, the circumstances in which they were temporarily placed rendered an immediate junction impracticable The reply had reference to certain defects in the Act which required amendment, and also to the difficulty in regard to accommodation.

The Institute was at this time housed in Green's Exchange Buildings, but an endeavour was being made to secure more commodious premises. Owing to the difficulty of obtaining suitable rooms, the Board at length decided to apply to the Government for the erection of a building on public land. It was estimated that the cost would be approximately £4,000, and immense energy was displayed by all parties to induce Parliament to make this sum available for the purpose.

Not the least active participant in these proceedings was the Philosophical Society. Among the papers preserved in the Archives is a draft memorial to the House of Assembly, in the handwriting of John Howard Clark, who was then Hon. Secretary.

Inter alia this memorial states:—"Your memorialists are authorized to negotiate for the incorporation of the Adelaide Philosophical Society with the South Australian Institute. . . . It is impossible that such incorporation can be effected, until the S.A. Institute has at its disposal a permanent and suitably designed building, affording ample accommodation for its various requirements. One of the principal objects of our Society is the formation of a Museum illustrative of the Natural History of the Province, and it is useless to take any steps in furtherance of this object until a suitable room is provided for preserving the specimens collected, although valuable specimens would then be immediately available, many of which in a few years' time it would be impossible to replace."

Parliament found it impossible to resist the pressure brought to bear upon it and the sum was passed.

The next matter that aroused great controversy was the site of the proposed building. Parliament had selected a site between the back of the present City Baths and the Cheer-up Hut. This evoked the most heated discussions in the newspapers, and resulted in many deputations and public meetings.

The Philosophical Society threw the weight of its influence into the scales on behalf of a more prominent and accessible position In addition to much private wire-pulling, they embodied their views in another memorial to His Excellency Sir R G. MacDonnell, at that time their President. Once more the well-known caligraphy of J. H. Clark can be recognized in the draft. 'Your memoralists have learned with regret that it is proposed to erect a building, to be devoted to the objects of the Institute, in a locality which appears to them to be objectionable in many respects; inasmuch as the site selected is so much lower than North Terrace, that not only will the building (which should ultimately become one of the chief ornaments of the city) be almost hidden from sight, but its situation will be neither convenient for public access, nor advantageous for meteorological observations, whilst the steep gradient of the City Bridge Road will necessarily render the approaches to the building unsafe for the large number of vehicles, which will hereafter be frequently gathered together at night, on the occasion of lectures or soirees connected with the Institute or its affiliated societies. . . . Inasmuch as the Houses of Parliament are, and long will be, amply sufficient for the requirements of the colony, it is needless to leave unoccupied the excellent site for an important public building, which could be made available at the corner of North Terrace and the City Bridge Road, and which is at present said to be preserved for future new

Houses of Parliament Your memorialists pray that Your Excellency will be pleased to direct, that the building for the S.A. Institute may be erected upon the site last mentioned, or upon some other site better suited to the present requirements and ultimate importance of the Institute than that now in contemplation "

Once again the faith of the Society in memorials was justified. Parliament meekly bowed its head before the storm of public protest, and the proposed site was changed to that occupied by the Institute to-day.

In this, as in all public matters which touched its objects or its principles, the Society was ever ready to fight for the common interests of itself and its friends. Impecunious as it was, it possessed in great measure the brains of the small community, an endowment of greater importance and influence than mere material wealth. It was instinctively alert to recognize the value of powerful friendships, such as that of the Governor of the colony, and, above all, it fully realized and appreciated the power of the Press.

Under the Act, the subscribers to the Institute exercised the privileges of an incorporated Society, and at the first annual meeting in October, 1857, they rewarded the services of J. H. Clark by electing him as their representative on the Board of Governors, an undoubted honour for so young a man.

The Society's tenacity of purpose was one of its most valuable assets. In its early infancy it had desired a Museum, a desire constantly foiled by almost insuperable difficulties and only realized when passing into middle age. But until realized its purpose was always in evidence. Persistent flagellation of the public interest, as well as that of the Governing Board, kept the matter alive, or at least in a state of suspended animation.

In its first report, the Board speaks hopefully of the early accomplishment of this object. "As regards a Museum, the prospects of the Institute are most satisfactory. Extensive collections of great and varied interest await only a room for their reception. The proprietors of mines in this colony have in all instances complied with the request of the Governors to be furnished with specimens characteristic of their various properties, so that at its opening the Museum will exhibit an epitome of the mineral riches of South Australia. To the Directors of the Burra Mine, the Governors are indebted for a very extensive and interesting collection just lately come to hand Many valuable presents are also promised by private individuals His Excellency Sir George Gray writes from Cape Town, in reply to an application made on behalf of the South Australian Institute, that he has directed many interesting specimens to be collected and forwarded hither, including a complete series of the copper ores of the colony over which His Excellency presides."

"The Governors believe, that when the Museum is established many other additions to its contents will be received from abroad, and that many of our own colonists, who are known to possess miniature museums, will be anxious to incorporate them in the public collection."

In their second report, October, 1858, they acknowledge receipt of the collection presented by Sir George Gray and also the purchase of "a very interesting and extensive collection of shells."

It will be seen from the tenor of these reports, that the institution at this time in the minds of the Governors was almost entirely a mineralogical collection, and very far removed from the Natural History Museum, which was an early objective of the Society. Nevertheless, it indicated a slight advance in the right direction

(c) Incorporation with the S.A. Institute.

Incorporation of the Philosophical Society with the S.A. Institute was duly effected in October, 1859. The terms, however, were less favourable than the Society had anticipated. It was to receive certain clerical services from the Institute, but a room for its exclusive use was refused and accommodation was guaranteed for monthly meetings only. For the privileges of incorporation, the Society was to contribute one-third of its gross annual income, but the minimum contribution was fixed at £15. In a letter to the Society, of which he was still Secretary, Mr. Clark carefully points out that "the sum required is not so much in the nature of an amount paid away for house rent and clerical services, as a contribution towards a fund to be expended for the general benefit of all connected with the institution, and in the expenditure of which the Society will have a voice." He illustrated his meaning by the statement that the Governors had already sent to England for a valuable microscope and a pair of 36-in. globes, and that doubtless with accession of funds the stock of philosophical apparatus would be speedily increased.

It is to be feared that in the years that followed the Society too often lost sight of this statesmanlike view, when the hand of adversity pressed heavily upon it.

The Society was, of course, now entitled to elect a representative Governor, and its first choice fell upon B. H. Babbage, who was a foundation member and its President from

1855-6. Another of its most active members, Mr. Whitridge was also elected to the Board by the Society of Arts, so that with three of its prominent members on the Executive of the Institute, its interests would appear to be well protected.

A delay arose in the erection of the building, and meanwhile the Institute continued to occupy the premises in Green's Exchange and the Philosophical Society those in White's Commercial Rooms, King William Street.

The new building was opened with great ceremony by His Honor Sir Charles Cooper on January 29, 1861. The room allotted to the Society was upstairs, immediately over the library, with a south-easterly aspect. Its floor has recently been removed to increase the shelving accommodation for books.

The Museum consisted chiefly of a mineralogical collection, and occupied a long narrow room running across the upper story at the rear of the building. There it remained under the curatorship of F. G. Waterhouse, naturalist in McDouall Stuart's Expedition, for a period of twenty years. During all these years, very little expansion was possible, owing to the lack of space, and it was not until it was removed to more commodious premises that any serious attempt to form a zoological collection could be entertained.

Incorporation with the S A. Institute was certainly not followed by the signal advantages hoped for by the Philosophical Society. In many ways it proved a grievous disappointment.

In the first place, the limited accommodation afforded to the long-desired Museum had to a great extent shorn that institution of its utility. In no sense could it be regarded as a collection representative of the natural history of the colony, and it was therefore of little value as an attractive and popular set-off to the technical aspect of the Society's work. In this matter the Board was powerless to help, not that it was lacking in sympathy, but merely because the building was altogether too small for the purposes to which it had been dedicated .

Then, again, the Society had hoped to derive some financial advantage from the union. The Amending Act gave the Board power to advance moneys to incorporated societies; and the Consolidated Act of 1863 also gave it discretionary power to make a grant to any Society so incorporated.

In addition to the annual subsidy made by the Government to the central institute, sums of varying amount were also paid to it for allocation among affiliated country institutes. It was clearly the intention of the Legislature, that the Philosophical Society as an incorporated body should benefit under the Parliamentary vote, yet the Estimates were so worded that it was precluded from this privilege.

It was not until many years later (1878) that this disability was removed, and it was placed on an equality with country institutes, receiving, like the latter, an annual Government subsidy equal to the subscriptions for the current year.

Thus for nearly twenty years it paid to the Institute out of its small income of about £50, a sum which it regarded as practically a rental, for the empty privilege of electing a Governor, who was powerless to promote its interests or adjust its grievances.

It is suggestive of its poverty, that for several years after incorporation the publication of the brief annual reports suddenly ceased. The balance-sheets show, that since its foundation the Society had been striving to establish a reserve fund, which in 1858 stood at £77. This sum would have more than sufficed for the continuation of the reports, but it is probable that in view of an uncertain future, it had been decided to temporarily discontinue them and depend for publicity upon the goodwill of the newspapers. Such strict economy may also have been prompted by a desire to assist in the furnishings of the Museum, about which much difficulty had unexpectedly arisen; for it is on record that in 1861, the substantial sum of £50 was expended for this purpose.

At this period of its history, the Society was extremely isolated from the scientific world, having no publications to exchange for the Proceedings of other bodies and having practically no funds wherewith to effect purchases. As early as 1863, the position had indeed become so acute that it clearly contemplated secession, and was only deterred by the fear of losing its property. In a letter to the Board dated June 15 of that year, the Council wrote requesting it to confer with their Special Committee as to the interpretation which should be placed upon certain clauses in the terms of incorporation. It may be here pointed out, that the Board had retained the right to place its own construction upon any debatable terms in this agreement. The letter proceeds:—"The Committee particularly desires to know the views of the Board, under the possible circumstances of entire removal of the Philosophical Society to other premises. Also upon the restraints which the terms of incorporation have upon the Society; its rights to remove, sell, exchange, or otherwise dispose of its movable property, such as specimens and instruments. Also upon any independent power which the Governors may claim to exhibit, remove, lend, or use any of such property without previously obtaining the consent of the

Society Also seeing, that by the Act, the Governors have power to make bye-laws, whether such bye-laws would alter the interpretation now given, relative to the terms of incorporation.''

The letter was not wholly without guile If they could remove their property to other premises, without fear of confiscation, then the path would be open for any future course of action they might desire to pursue

The reply from the Board, however, was guarded, and in the nature of a compromise which did not materially improve their position. It announced, that as a result of the conference, "the Board are willing to modify the articles of incorporation between the S A. Institute and the Philosophical Society, so as to make them accord with the incorporation clauses of the schedule of Statutes and Rules." This meant that property could only be removed with the consent of the Governors, and with this proviso, should vest in the S.A Institute, only in the event of dissolution of the incorporated Society.

The schedule of the Acts of 1855-6 had provided that property accumulated by incorporated societies should become vested in the Institute *forthwith and without reservation* But this was a schedule which the Board had power to alter or amend, subject to the approval of the Legislature, and which had already been so amended in 1861.

A new Consolidated Act, embodying the undertaking of the Board, duly received assent the following November.

The room in which the Society held its meetings was only at its disposal for twelve meetings a year, whereas the actual number of meetings exceeded this. It was inadequately furnished, and it was therefore necessary to incur the expense of erecting a cupboard and shelving, of which the Society had to bear half the cost.

The one bright spot in the landscape at this period was due to the unvarying kindness and sympathy received from the Press. Although the Society had no means of communicating its work to the scientific world, its members continued to read their papers, and the Press, out of the greatness of its charity, continued to publish them.

After reading the reports of the S.A. Institute, one is forced to conclude that the difficulties which confronted the Philosophical Society after its incorporation were not the callous creation of the governing body of that institution. The very constitution of the Board precluded a charge of indifference. Even the Secretary (Robert Kay) was a foundation member of the Society and a man of strong personality.

The fact was, there was no period in the history of the institution when it had money to burn. The Act was permissive, and when the loudly-voiced demands of the subscribers and country institutes had been met, there were no funds left in which the Society might participate.

Nevertheless, the Society continued to do good work; many of its papers were of high quality, and it continued to interest itself in economic matters of public utility.

In 1862 it attempted to establish an Acclimatization Society. For this purpose it appointed a Committee to carry out this object. Much information was collected and an important paper was prepared and read by Mr. G. W. Francis, an enthusiastic advocate of the movement. This paper was published by the Society, and duly circulated, but did not create sufficient public interest to warrant further steps in regard to the matter. About a year later, however, such a body was duly founded in Adelaide, the success on this occasion being undoubtedly due to the earlier efforts of the Philosophical Society.

Another matter which claimed its serious attention in 1866 was that of the city drainage, a subject of great importance to Adelaide from the standpoint of the health and comfort of its citizens. A series of resolutions were formulated and embodied in a memorial to the City Council, with the result that a Bill was introduced into the Legislature to enable the Corporation to initiate a modern system of sanitation.

In the same year, the question of railway gauge exercised the minds of its members and formed the subject of much interesting discussion. The result of this was the adoption of several resolutions, one of which was: "That the saving in the construction of a 3 ft. 6 in. line over that of a 5 ft. 3 in., calculated for a similar amount of traffic, would be by no means proportionate to the difference of width of gauge, and that our branch lines should be constructed as lightly and as cheaply as possible with a 5 ft. 3 in. gauge and worked with horse-power, until the amount of traffic renders the use of a light locomotive at low speed more economical."

Towards the close of 1870, there had been held nearly 170 meetings at which upwards of 200 papers had been read. Many of these dealt with geographical exploration and branches of applied science relating to horticulture, metallurgy, and meteorology; others were important contributions to the geology and natural history of the Province.

John Howard Clark became Hon. Treasurer in 1863, a position which was not without its penalties. In 1866, the financial statement shows a small balance of £1 16s. 10d. due to the Treasurer. The annual exhortations by the Hon. Secretary requesting the members to promptly meet their obligations do not appear to have met with a ready response, for the following year the subscriptions had still further fallen off, and the amount due to the Treasurer had increased to £30.

The Council recognized two possible ways of adjusting this unsatisfactory state of its finances. The first was by curtailment of expenses, which could not be done without diminishing the usefulness or impairing the attractiveness of the Society; the other way was by a material increase in its membership. The second alternative was chosen as a solution of the difficulty, but it evidently failed, for in 1868 it was found necessary to realize upon the property. This was done by effecting a sale of some museum cases to the S.A. Institute for a sum of £40. As these same cases had cost them £50 a few years previously, the transaction could not be regarded as altogether a favourable one. It enabled the Society, however, to restore the Treasurer's account to an equilibrium, leaving it with a small credit balance for the year. This balance was increased the following year, by a still further encroachment upon the property. This time it was a sale to the Institute of the valuable set of Transactions of the Royal Society of London, for a sum slightly in excess of the original cost. The proceeds of the sale were received in two annual instalments. The cost of printing the yearly report and transactions for the succeeding year was, however, greatly in excess of what had been previously paid, so that 1870 ended with a much more slender balance than had been anticipated.

The colony had now fallen upon troublous times, and these were reflected in the fortunes and finances of the Society. In its report for the two years ended September 30, 1872, the Council, while expressing its satisfaction at the growing interest in its proceedings by the public, as exhibited in their general attendance at its meetings, nevertheless directs attention to the fact, so significant of the times through which it was passing, that out of 62 ordinary members, only 34 had paid their subscriptions for the current year.

It is not therefore surprising, that a letter dated 8/2/71 should be found amongst the correspondence in the Archives, asking the S.A. Institute to reduce the contribution to £12 per annum. Two reasons are advanced in support of this request: (1) "Because we can secure a comfortable room in the Town Hall for 10s. 6d. per meeting," and (2) "because our expenditure is in excess of our income." The request was granted.

The time had evidently arrived for drastic retrenchment, and no further reports of transactions were published for five years.

(d) Establishment of the University and the Coming of the Grant.

Although the prevailing depression in the colony in the early seventies had robbed the Society of that vigour which had characterized it in previous years, two all-important events were about to arouse it into unprecedented activity and usefulness. These were the establishment of the University and the coming of the Government grant.

The influence exerted by the University can hardly be over-estimated It did not intrude itself gradually, but was almost cataclysmic in its suddenness. The Society began to radiate vitality. The scientific leader for which it had waited so long appeared in the person of Professor Ralph Tate, whose energy was tremendous. Popular lectures were delivered, public interest was aroused, resulting in a sudden accession of strength to its ranks and a welcome increase in its funds. Effort and knowledge now became organized, and the Society was soon raised from a mere parochial body to an assured place in the scientific world.

The following year the publication of its Transactions was resumed and appeared in a form more in accordance with those issued elsewhere.

Throughout this new phase of development there was, however, always present the lurking fear of adversity. At all costs some permanent source of income must be discovered, to assure them against any further breaches in the continuity of their publications. In 1879 the Council once more approached the Board with a view of securing some financial benefit under the Institutes Act. Acting on the advice of the Board, and with the promise of its assistance, an application was made to the Government, asking that the Society should receive the same measure of support as had hitherto been accorded to the country institutes. The application was favourably considered, and resulted in an annual subsidy on their subscriptions. The subsidy for the year in question amounted to £118, which, though it did not enrich them, at least defrayed the cost of their Transactions and left a few pounds over for emergencies.

Since then the Society has never looked back. Its publications have been continuous for forty-five years, and are now to be found on the shelves of every important scientific library throughout the world.

(4) THE ROYAL SOCIETY OF SOUTH AUSTRALIA.

(a) How we became "Royal."

At the close of the seventies it became apparent to the Society that its investigations would receive added weight and dignity if it could include in the title a warrant of Royal favour. In other words, it appeared that there was something in a name.

The occasion was an unusual one, and it was not known to the Council what procedure should be adopted to solicit the patronage of its Sovereign. There were at that time in Australia three Societies that rejoiced in the title of "Royal"; one in New South Wales, one in Victoria, and in Tasmania one that had been founded many years previously by Sir John Franklin. Mr. Walter Rutt, who was then, as now, Secretary of the Society, accordingly wrote to the Secretary of the latter body, inquiring as to the steps which had been taken when they had solicited a similar privilege. Dr. Agnew replied, that it had been necessary to make a search through the records in the Colonial Secretary's Office, and subsequently through His Excellency's despatches, for the purpose of obtaining specific information on this subject. Even then his search had been unsuccessful, but he had learned from Mr. Hull, a corresponding member of the Philosophical Society, and in 1843 a confidential member on the staff of Sir Eardley Wilmot, that on the occasion in question a despatch was sent to the Secretary of State, conveying a request that Her Majesty would be graciously pleased to become a Patron of the Tasmanian Society. At the same time, the claims of the Society to this mark of favour were duly set forth. A favourable reply had eventully been received from the Home Government, and it had since enjoyed the title of "Royal." A subsequent letter from Dr. Agnew conveyed the information that the despatch from Lord Stanley, Secretary for the Colonies, had been found. It stated that Her Majesty had graciously consented to become the Patroness of the Tasmanian Society, and had acceded to the request that it should be permitted to use the title "Royal."

Acting on this precedent, the Council of the Adelaide Philosophical Society addressed the following request to Sir William Jervois, then Governor of the colony:—

"The Adelaide Philosophical Society, knowing that there is a wide and comparatively unexplored field for scientific research in this extensive Province of South Australia, is appealing to all who take an interest in such matters, to forward to the Society the results of their observations and investigations, in order that they may be collated and placed on record for the benefit of the scientific world. The Council feels that a more ready response would be made to this appeal, and that more attention would be given by men of science throughout the world, if Her Majesty would graciously extend to it her patronage. In this view members of the Society concur.

"I am therefore instructed to request you to kindly take the necessary steps to lay before the Queen the prayer of this Society, that Her Majesty will graciously consent to become the Patron of the Society, under the title of 'The Royal Society of South Australia,' and thus place it upon an equality with the Royal Societies existing for similar purposes in other Australian colonies.

"If Her Majesty should be pleased to accede to this request, you would perhaps, as representative of the Crown in this Province, not object to accept the position of Vice-Patron

"The Society has done a considerable amount of work, and is desirous of widely extending its operations in the future."

His Excellency, a punctilious observer of the formalities, in his reply submitted the following suggestions for consideration by the Society:—

1. That the Society's application might conveniently take the form of a memorial to Her Majesty, and if on parchment, should be accompanied by a copy on folio paper. It should bear the signatures of the President and principal officers of the Society.

2. As to matter, it would probably be of advantage, if the memorial contained, after the opening statement, a concise sketch of the origin and progress of the Society, of its funds, numbers, times of meetings, circle of subjects hitherto embraced, and transactions generally. Something should be stated as to the results attained. The memorial should also be accompanied by four copies of all printed matter relating to the proceedings of and subjects treated by the Society.

He pointed out that the application was in a measure on the same footing as that recently made by the University of Adelaide for a grant of Letters Patent, and, as in that case, a clear statement of the nature and position of the Society is requisite to obtain the object in view.

A memorial embodying the above suggestions having been submitted to His Excellency, he approved of its form, but deemed it advisable, as a preliminary step, that it should be adopted at a full meeting of the Society.

The following memorial was at length forwarded by His Excellency:—

"To the Queen's Most Excellent Majesty.

"May it please Your Majesty.

"We the undersigned, acting on behalf of and at the request of the Council and members of the Adelaide Philosophical Society, as expressed by a resolution passed at a meeting of the Society on the 4th day of May, 1880, humbly lay before you our prayer, that Your Majesty will be graciously pleased to become the Patron of the Society under the title of 'The Royal Society of South Australia.'

"The Adelaide Philosophical Society was founded in 1853, for the diffusion and advancement of the Arts and Sciences, by the meeting together of the members, for the reading and discussion of papers connected with the above subjects and by other approved means; and was, in 1863,(2) incorporated with the South Australian Institute, under the provisions of the South Australian Institute Act of that year,(3) which retained to such incorporated Societies their individuality and full independence of action.

"The Society has done much in the past to keep alive in a struggling and young community the importance of scientific research. The rapid extension of agriculture in districts which were until recently occupied only for pastoral purposes, the successful journeys of many exploring parties, the consequent advance of pastoral settlement in the interior and in the Northern Territory, the development of the country by railways and telegraphs, and consequent prosperity of the colony, have given increased opportunities and leisure for the collection of facts in the natural history of the Province, which has hitherto been a field almost unexplored by the scientific observer. The Society has, therefore, established correspondents throughout the Province, and the value of the results thus obtained and forwarded to the leading scientific societies of the world will be seen by an inspection of the two volumes of the New Series of the Society's Transactions, copies of which are forwarded for Your Majesty's information. The Old Series of Transactions, published only for distribution amongst the members, is now out of print.

"The Society, numbering at present about 110 members, meets monthly, and its income this year will exceed £200.

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(2) The year of incorporation was 1859.

(3) The Institute Act was passed in 1856, the Amending Act the same year.

"It will be seen that the objects sought, and the results obtained, by the Adelaide Philosophical Society are similar and equal to those sought and obtained by the Royal Societies of New South Wales, Victoria, and Tasmania, and we feel that the Society will be largely assisted in its efforts to increase the value of those results, and that more attention will be paid by scientific men throughout the world, to the facts recorded year by year in its Transactions, if Your Majesty will be graciously pleased to accede to the request of your memorialists, who will, as in duty bound, ever pray, etc.

"RALPH TATE, President.
"FREDK. CHAPPLE, } Vice-Presidents.
"CHAS. TODD, } Vice-Presidents.
"THOMAS D. SMEATON, Hon. Treasurer.
"WALTER RUTT, Hon. Secretary."

Four months later a letter was received by the Governor, enclosing a copy of a despatch received from the Secretary of State for the Colonies:—

"South Australia. Downing Street,
"No. 24. 3rd August, 1880.

"Sir—I duly received your despatch No. 31 of the 15th May last, and submitted to Her Majesty the Queen the memorial from the Adelaide Philosophical Society, praying that Her Majesty might be pleased to become the Patron of the Society, under the title of the Royal Society of South Australia.

"I have now the honour to request that you will inform the President of the Society, that Her Majesty has signified her gracious approval of the Society being styled the Royal Society of South Australia.

"I have the honour to be, etc., etc.,
"KIMBERLEY."

The final letter in this correspondence is from the Private Secretary to the President of the Royal Society of South Australia, dated 20/1/81, informing him that His Excellency wishes that the future volumes of the Royal Society should be forwarded to the Secretary of State for the Colonies, through him, and requesting the President to transmit to him three copies of the volumes in question, as published.

(b) New Buildings and a New Act.

Almost from the beginning it was recognized that the accommodation in the S.A. Institute was inadequate for the purposes of a Museum. This became more and more apparent as time went on, and the restrictions which the limitations of space placed upon the collection rendered it practically valueless for natural history purposes. Not only was accommodation insufficient for Museum purposes, but pressing need for expansion was also felt by the library and other departments under control of the Board. Similar inconvenience was experienced by the incorporated Societies, and the Philosophical Society, whose meetings were now open to the public, found their room uncomfortably crowded, when any subject of special interest was being discussed

It became almost painfully evident at the end of the sixties that a new building was an urgent necessity, and in 1871 Parliament, without dissentient voices, expressed its sympathy with the proposed enlargement. The Board recommended the erection of a new building to the east of the Institute, to consist of two wings, of which the western one was to be proceeded with first

Money was found by the Government for this purpose and the foundations were duly laid down in 1873. There seems, however, either to have been a lack of unanimity with regard to the proposed scheme, or else a desire on the part of the Government to delay public expenditure, for at this stage building operations ceased and a Royal Commission was appointed to inquire into the whole matter.

The Commission favoured the idea of a Public Library and Museum to replace the Institute, and recommended that these should form two wings of a new building, to be erected to the east of the latter. No attempt was made to carry out this recommendation until 1876, when it was discovered that the foundations which had been laid three years previously were unsound. New ones were laid, but these were again temporarily abandoned for two years, when it was found that they, too, had to be taken up and replaced. The foundation-stone of the present Public Library was ultimately laid in 1879.

This time the erection of the new building proceeded rapidly and without further delay. The western wing (now the Public Library) was sufficiently advanced for occupation in 1882, and as the Institute rooms occupied by the Museum were required for the new School of Design, the collection was withdrawn from public view, and placed in the crypt and two smaller rooms of the new wing in the early part of that year.

Here it was submitted to a critical examination by Dr. Haacke, the new Director. This gentleman on his arrival stated his views very frankly as to what he considered the S.A. Museum ought to be. "In the first instance," he says, "there should be in South Australia no institution rivalling the Museum under my care, as this would not tend to further the scientific and educational interests of the colony. In Adelaide we enjoy the existence of a Botanic Garden, with a Museum of Economic Botany, and of a University with a museum for lecture purposes; a Zoological Garden is now to be established, and we shall have a Technological Museum in course of time. There are also small museums connected with some of the country institutes, and the Royal Society is endeavouring to promote the intellectual and scientific advancement of the colony In the interest, not only of the Museum, but of all the above institutions, I respectfully beg you to take the following suggestions in the spirit in which they are made.

"I think it would be wise to exclude any technological and botanical collections from the present Museum, where, however, all objects of zoology, ethnology, mineralogy, and geology should be gathered, as long as it is not thought advisable to have special museums for each of these branches of science.

"In the Zoological Gardens to be established, only living animals should be kept, and the museum in connection with the University should only contain such collections as will be useful in lectures. Again, the country museums should be satisfied in having only good educational collections, while all objects of scientific value should go to the central institution, which, in connection with the Botanic Gardens, the University, and the Royal Society, ought to represent science in South Australia."

He then proceeds to outline the manner in which, in his opinion, the collection should be displayed.

I think there are very few of these suggestions which would fail to meet with approval to-day.

Two years elapsed before the collection was considered to be sufficiently advanced for public exhibition. A portion of it was then displayed in the northern half of the present Library, which remained its home for ten or eleven years.

In 1894, that portion of the building occupied by the Museum was urgently required for Library purposes, and the collection was once more removed, this time to the present brick building which connects the two wings of the institution.

It is within the recollection of most of you, that at quite a recent date further room for expansion was urgently needed, and most of the eastern wing was appropriated for that purpose. Then only were the early dreams of the Philosophical Society almost realized, by the existence in this city of a Museum containing an excellent and representative collection of the natural history resoures of the State, and among other things the finest Australian anthropological and ethnological collection in the world.

Even now the buildings are overcrowded, and there are many important specimens which have to be stored until space can be found for their exhibition. There are also gaps in the collection, some of which at this late period in our history we cannot hope to fill, but there are likewise *desiderata* which we still hope to receive from the hands of some diligent and patriotic collector.

At all times the most cordial relations have existed between our Society and the scientific staff of the Museum. They have, I believe, in every instance been amongst the most honoured and respected members on our roll. Since 1884, when the Museum first became an institution worthy of the name, a representative of the Council has always been Chairman of its Committee, a position which Professor Howchin has honourably discharged for the past twenty years. One can have no hesitation in saying, that it is now fulfilling the high scientific functions for which it was established and towards this success it would not be immodest for the Royal Society to claim some degree of credit and responsibility.

The passing of the Public Library Act of 1884 created a somewhat curious situation, which at first appeared to threaten the interests and stability of the Royal Society.

This Act, which abolished the S.A. Institute and superseded it by a Public Library, Museum, and Art Gallery, renewed the privilege of the Society to elect a representative Governor on the Board, but unfortunately it did not make provision for the incorporation or affiliation of societies.

Without such provision the alarming fact became disclosed, that the Government grant which the Society had now enjoyed for several years had quite suddenly lapsed, and the Society had therefore incurred liabilities during its financial year which there might be no means of meeting.

It was a very anxious and perturbed Council that opened up a correspondence with the Board on this all-vital question in August of 1884. In reply to their inquiry as to how the position of the Society and the Government subsidy would be affected by the new Act, they were informed that the Act had put an end to the S.A. Institute in the previous June, and, of course, at the same time to the incorporation with it of the Royal Society. Further, that the Estimates for the current year provided grants to country and suburban institutes and also to affiliated societies; that as it might not be advisable to alter the wording of the line on the Estimates, the safest course for the Board to pursue would be for it to pass a formal minute declaring the Royal Society to be a Society affiliated to the Public Library, Museum, and Art Gallery. This, however, was a step which the Board could not take unless asked to do so by the Council.

Of course, the latter body lost no time in making the request, to which, however, they received the startling reply, that it had been discovered that the Act gave the Board no power to affiliate societies; it would, however, take the necessary steps to obtain such power.

This led to the passing of a short Amending Act the following year, and affiliation between the two bodies was then duly effected.

Another little matter, which resulted from the termination of the union between the Society and the S.A. Institute, may be of interest as involving a principle. An early intimation was received from the Board, that after June 30, 1884, the Society would be relieved of any further payment for the use of its room, except for the cost of gas consumed at its meetings and those of its branches; further, that in future it would receive no assistance in clerical work from the Board's officers.

It was about this time, also, that owing to the rapid growth of the School of Design, it became necessary for the Society to vacate its old room in the Institute and occupy a more commodious room in the new wing of the Museum. They remained there until 1891, when the School of Design, having removed to the Exhibition Building, the Society, with the consent of the Board, returned again to its old quarters in the Institute.

(c) Establishment of Sections.

As early in its history as 1858, a Committee was appointed to consider the expediency of dividing the Society into sections, each of which should be specially charged with the supervision of certain subjects. No less than ten such sections were proposed, and it was probably owing to their multiplicity that the scheme fell through.

In 1883 the idea was revived, though from a different point of view. It was thought that there existed a need for a section of a popular nature, which would also serve as a recruiting ground from which the Society might increase its membership. Thus was established the Field Naturalists' Section. It was intended for studiously disposed persons, of either sex, who wished to undertake the study of natural history from an elementary standpoint.

Professor Tate, from whom the proposal had emanated, delivered an interesting lecture in the Town Hall, explaining the objects of the Section. No scientific qualification was demanded from intending members. The Field Naturalists' Section certainly met a public want, and has had a vigorous existence for about forty years.

Its success led to the establishment of other Sections, such, for instance, as the Microscopical, the Malacological, etc., none of which, however, have survived.

(d) The Society's Library.

It does not appear necessary to treat in detail the later developments and activities of the Society, for they are permanently embodied in its Transactions and are comparatively modern history.

As the years passed the number of foreign exchanges was ever on the increase, until the library began to assume formidable proportions. As the room was small, and the shelving ludicrously inadequate, it became necessary to stack many of the books on top of each other, so that they were quite inaccessible for consultation by the Fellows. Frequent references are to be found in the annual reports in regard to this matter. In 1890 it is stated "The Council is far from satisfied with the present conditions under which the books of the library have to be kept. It had been hoped that by this time arrangements might have been made to have them so placed in some portion of the Public Library that members could have access to them at any time during the day. It feels that the present unsatisfactory condition cannot be allowed to continue, but that every effort must be made to place at the disposal of the Fellows the library in a more efficient way."

The next annual report shows, that during the year increased shelving accommodation had been provided, and that the books had been arranged in easily accessible positions. This report adds, that in order to make the library still more comprehensive and complete, the Council had put itself into communication with a number of American and European scientific societies, whose publications had been solicited in exchange for our own.

Some ten years later it is announced, that "donations from scientific bodies have so largely increased of late, that the possibility of making the vast amount of material available becomes a very urgent question."

Accordingly a card catalogue was prepared, and this brought to light many breaks and irregularities in the sets of serial literature. A Committee was now appointed to inquire into the whole question of the library and its arrangement. This Committee came to the conclusion that the only solution of their difficulties was the transfer of their books to the Public Library, because the Society had neither accommodation for the books nor a librarian to look after them.

At this juncture the Government was approached with a view to securing better accommodation for the Royal and other local societies. The result was that additions were made to the northern end of the Institute Building, and fine premises were erected capable of comfortably accommodating all affiliated Societies together with their respective libraries and property. It was completed and suitably furnished in 1907, and the large western room on the ground floor, where we now hold our meetings, was allocated by the Board for the purposes of the Royal Society, a smaller room between this and the York Gate Library being apportioned for the common use of the two bodies. Under these greatly improved conditions, it was at last possible to introduce order, where chaos had formerly prevailed.

As the Geographical Society occupied the adjacent room, it was at first thought that economy might be effected by the two Societies sharing the services of a single librarian, who should also act as their common Secretary. Unfortunately this scheme did not eventuate, and each Society subsequently appointed its own officer.

The Society is under a debt of gratitude to Sir Joseph Verco for the great personal interest he has displayed in the reorganization of the library. Only those of us who remember the old order (or disorder ?) of things, can fully appreciate the nature of the change that has been effected during his Presidency.

In 1921, the following exchanges of publications were made with learned societies in other countries:—United Kingdom, 27; Continental Europe, 66; Canada, 4; South Africa, 6; Sudan, 1; India and Ceylon, 6; United States, 50; Mexico, 2; Brazil, 1; Uruguay, 1; Peru, 1; Argentina, 1; Japan, 3; China, 1; Philippines, 1; Straits Settlements, 1; Java, 2; Hawaiian Islands, 2; Commonwealth of Australia and New Zealand, 54. Total, 231.

(e) Research and Endowment Fund.

In 1903, the Society was incorporated, in order that it might acquire and hold property.

The chief object of this was to enable it to establish an Endowment Fund, for the purpose of meeting special liabilities and also for the promotion of scientific research. Thanks to the generosity of Sir Joseph Verco, the late Thomas Scarfe, and the late R. Barr Smith, each of whom donated the sum of £1,000, this fund has now been in operation for some years.

5. Conclusion.

The total number of members on our roll is 102. Fully half of these have contributed papers which have been published in the Society's Transactions, many of which must be regarded as very important additions to the literature of science. It is not my task, however, to particularize—it would, in fact, be invidious for me to do so. But there is one name, which I feel sure you would like me to mention—the honourable name of our senior Fellow, Walter Rutt, the connecting link between the old order and the new. Mr. Rutt was elected fifty-three years ago, when the Society was still in its callow youth, and during nearly the whole of that long period he has been a member of the Council, chiefly in the capacity of Hon. Secretary or Hon. Treasurer. He has also filled the office of Vice-President. He has accompanied the Society through all its vicissitudes of fortune, and is the authority to whom one naturally appeals for information on every important event in its history. Though he has contributed but few papers to its Transactions, yet in wealth of service he is probably its chief benefactor.

APPENDIX I.

List of Foundation Members Elected in the Year 1853.

†Babbage, B. H.
Babbage, Dugald
Bompas, Dr. J. C.
Brown, Dr. John
Clark, A. Sydney
Clark, Francis
*Clark, John Howard
†Davy, Dr. E.
Davies, Dr. Chas.
Doswell, C. M.
*Feinaigle, C. G.
Freeling, Capt. Arthur H.
Garran, Dr. Andrew
Gilbert, W. B.
*Gosse, Dr. Wm.
Hamilton, Edward
Hamilton, G. E.
Hammond, Octavius
Hanson, R. D.
Hays, W. Bennett
Kay, Robert
Kingston, G. S.
Mann, Charles
Martin, E. M.
Moore, Dr. R. W.
Moorhouse, Dr. Matthew
Mayo, Dr. George
Nootnagel, H.
Quick, N. S.
Sholl, W. H.
Stow, R. S.
†Whitridge, W. W. R.
Williams, T. G.
Wilson, C. A.
Wooldridge, Dr. H.
Young, Sir H. E. Fox
*Young, John L.

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*Attended the first preliminary meeting.
†Attended the second preliminary meeting.

APPENDIX II.

Officers of the Society.

(a) *PAST-PRESIDENTS

Sir H. E. Fox Young (2)
B. Herschel Babbage (1)
Sir R. G. MacDonnell (6)
Sir Dominic Daly (7)
Sir James Fergusson (5)
Sir Anthony Musgrave (4)
Sir William Jervois (1)
Professor Ralph Tate (5)
Sir Samuel Way (2)
Sir Charles Todd (1)
Dr. H. T. Whittell (1)
Professor Horace Lamb (1)
H. C. Mais (1)
Professor E. H. Rennie (6)
Sir Edward Stirling (1)
Rev. Canon Blackburn (2)
Professor Walter Howchin (2)
Dr. W. L. Cleland (3)
Sir Joseph Verco (19)
Dr. R. S. Rogers (1)

(b) VICE-PRESIDENTS.

Babbage, B. H.
Freeling, Sir A. H.
Davies, Dr. C.
Farr, Rev. Canon G. H.
Forster, Hon. Anthony
Todd, Sir Chas.
Maughan, Rev. Jas.
Schomburgh, Richd. M.
Hosking, James
Ingleby, Rupert
Tate, Professor Ralph
Adamson, D. B.
Lamb, Professor Horace
Mais, H. C.
Mestayer, Richd. L.
Holtze, Maurice
Blackburn, Rev. Canon T.
Rogers, Dr. R. S.
Verco, Sir Joseph
Moorhouse, Dr. M.
Gosse, Dr. Wm.
Light, W. H.
Bruce, J. A.
Hanson, Sir R. D.
Wilson, C. A.
Waterhouse, F. G.
Hanson, W.
Smeaton, T. D.
Bonney, Chas.
Chapple, Frederic
Whittell, Dr. H. T.
Stirling, Sir Edward
Howchin, Professor Walter
Dixon, Samuel
Rennie, Professor H. E.
Rutt, Walter
Pulleine, Dr. R. H.
Ashby, Edwin

(c) REPRESENTATIVE GOVERNORS.

Babbage, B. H., 1859-1860.
Wyatt, Dr., 1860-1869.
Todd, Sir Charles, 1869-1884.
Whittell, Dr. H. T., 1884-1888.
Tate, Prof. Ralph, 1888-1901.
Howchin, Prof. Walter, 1901-1922.

(_d_) *Hon. Secretaries.

J. H. Clark (9)
T. D. Smeaton (1)
James Hosking (3)
J. S. Lloyd (5)
C. W. Babbage (6)
W. C. M. Finniss (3)
Walter Rutt (15)
Dr. W. L. Cleland (15)
W. C. Grasby (1)
W. B. Poole (2)
G. G. Mayo (10)
Dr. R. H. Pulleine (3)

(_e_) *Hon. Treasurers.

Charles Mann (1)
Dr. Andrew Garran (2)
A. Sydney Clark (8)
John Howard Clark (11)
T. D. Smeaton (8)
J. S. Lloyd (2)
Walter Rutt (23)
W. B. Poole (12)
B. S. Roach (1)

(_f_) Editors.

Professor Ralph Tate (16)
Professor Walter Howchin (29)

*The numbers enclosed in brackets indicate years of service.

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*Exploring Exped. from Fowler's Bay into Interior, Correspondence relating to.

*Incorporation with S.A. Institute, Papers relating to.

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*Minute-book (1853).

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  Fittings; Correspondence relating to and payment for, Parl Pap. No. 131 (28/8/60).
  Fittings; Petition to House of Assembly *re* (24/9/60), in file Pub. Lib.
  Minute-book, July, 1856-end 1858 (file of Pub. Lib.).
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*In the Archives of the Public Library.

Papers laid on the Table.—"Insect Metamorphosis," by O. W. Tiegs, M.Sc.; "Types of Species of Australian Polyplacophora now in the Museum of Natural History, Paris," by Edwin Ashby, F.L.S., M.B.O.U.; "Additions to the Flora of South Australia, No. 20," by J. M. Black; "On a New Genus and Species of Australian Lycaeninae from the Roper River," by Norman B. Tindale (communicated by A. M. Lea, F.E.S.); "A Preliminary Note on the Fossil Woods from some Australian Brown Coal Deposits," by Miss E. Dorothy Nobes, B.Sc.; "On the Ecology of the Ooldea District," by R. S. Adamson, M.A., B.Sc., and T. G. B. Osborn, D.Sc.; "Designs on Rocks in the Burra District," by John Biddle (communicated by A. G. Edquist); and "Ecological Notes on South Australian Plants, Part I.," by E. H. Ising.

Election of Officers.—Dr. Rogers declined renomination as President. The following officers were elected for 1922-23:—*President*, R. H. Pulleine, M.B.; *Vice-Presidents*, R. S. Rogers, M.A., M.D., and Sir Joseph C. Verco, M.D., F.R.C.S.; *Hon. Treasurer*, B. S. Roach; *Members of Council*, (*vice* Professors Chapman and Robertson, who retired by effluxion of time), Edgar R. Waite, F.L.S., and Professor T. G. B. Osborn, D.Sc.; *Hon. Auditors*, W. C. Hackett and H. Whitbread. It was also decided to appoint an Hon. Assistant Secretary, and E. H. Ising was elected to the position.

ANNUAL REPORT, 1921-22.

Two lines of research have been followed this year with the assistance of grants from this Society. Mr. F. R. Marston, who is seeking to obtain from azine precipitate samples of the pure proteolytic enzymes, has forwarded to the Council a progress report of his work, which, as his investigations are incomplete, he desires them to be regarded as confidential. Prof. F. Wood Jones' exploration of the Flora and Fauna of Nuyt's Archipelago and the Investigator Group has resulted in the collection of valuable specimens, which are being dealt with by experts, and papers on the subject by Professors F. Wood Jones and T. G. B. Osborn, Dr. Chilton, and Mr. A. M. Lea will appear in our forthcoming volume of "Transactions." The types of the new species obtained will be donated to the South Australian Museum.

The largest contribution to this volume will be a paper on "Insect Metamorphosis" by Mr. O. W. Tiegs, who also furnishes a paper on "The Anatomy of the Voluntary Muscles." Further papers on the "Polyplacophora," by Mr. Edwin Ashby, and the "Pouch Embryos of Marsupials," by Prof F Wood Jones, will be printed, and various branches of Natural Science, Chemistry, and Ethnology will be dealt with by Professors Sir Edgeworth David, Walter Howchin, Sir Douglas Mawson, T. G. B. Osborn, and J. B. Cleland, Drs E. O. Teale, R. S. Rogers, R. H. Pulleine, and A. Jefferis Turner, Miss Nobes, and Messrs. J. M. Black, F. Chapman, A. G. Edquist, P. A. Berry, R. S. Adamson, N. B. Tindale, and E. H. Ising.

The exhibits at the evening meetings have been numerous and interesting, including a series of views illustrating the Eucla Basin and its Water Supply, by Mr. L. Keith Ward.

The Library is continually increasing through the exchange of our publications for those of a growing number of learned societies and other public bodies, but no definite reply has yet been received from the Government to the request made for additional shelving.

The Index to our publications for the years 1901-1920 is in the printer's hands and will be issued early. Its publication, which has been delayed by the great labour of revising the proofs, will largely absorb the balance of our funds.

A suggestion having been made by the Queensland Branch of the Royal Geographical Society that a thorough exploration of the Great Barrier Reef should be made, Prof. F. Wood Jones was appointed to represent this Society upon a joint Committee to consider the proposal.

We have to report the death during the year of three of our Fellows—Dr. Sweetapple, of 15 years' standing · Mr. W. Ware, who was elected in 1878, and who served for many years as Hon. Auditor; and Mr. F. R. Zietz, who since his election in 1912 had taken an active part in the evening meetings by his papers, exhibits, and contribution to the discussions.

The present membership of the Society comprises 9 Honorary Fellows, 4 Corresponding Members, 87 Fellows, and 1 Associate.

R. S. Rogers, *President.*
Walter Rutt, *Hon. Secretary.*

September 30, 1922.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

REVENUE AND EXPENDITURE FOR 1921-22.

	£	s.	d.	£	s.	d.
To Balance October 1, 1921				595	15	6
,, Subscriptions—						
Royal Society	95	16	0			
Field Naturalists' Section . .	51	5	0			
				147	1	0
,, Grants from Government—						
On Subscriptions	120	5	3			
For Printing Reports and Scientific Investigations ...	150	0	0			
				270	5	3
,, Receipts for use of Room by other Societies	5	7	6			
,, Sale of Publications	4	18	2			
				10	5	8
,, Savings Bank Interest	15	15	9			
,, Interest transferred from Endowment Fund	177	2	10			
				192	18	7
,, Exchange on Cheques				0	1	3
				£1.216	7	3

	£	s.	d.	£	s.	d.
By Transactions—						
Printing	177	2	4			
Illustrating	38	2	6			
Publishing	13	11	11			
				228	16	9
,, Grants—						
Field Naturalists' Section ...	50	0	0			
Scientific Investigations ...	5	9	7			
British Science Guild	5	0	0			
				60	9	7
,, Library—						
Librarian, Cataloguing, Receiving, and Issuing	35	18	6			
Indexing	6	9	9			
				42	8	3
,, Sundries—						
Cleaning and Lighting ...	13	17	11			
Printing, Postage, Stationery	17	5	9			
Insurance	2	10	8			
Advertising	4	5	9			
Map Rack	4	19	0			
Repairing Chairs	3	6	6			
				46	5	7
,, Balance September 30, 1922—						
Savings Bank of S.A.	357	15	11			
Commonwealth Savings Bank	252	3	9			
Bank of Australasia	227	11	3			
Cash in Hand	0	16	2			
				838	7	1
				£1.216	7	3

Audited and found to be correct—

W. CHAMPION HACKETT, } *Hon. Auditors.*
O. GLASTONBURY, A.A.I.S., }

B. S. ROACH, *Hon. Treasurer.*

Adelaide, October 11, 1922.

ENDOWMENT FUND.

(CAPITAL, £3,844 6s. 10d.]

	£	s.	d.	£	s.	d.
1921—October 1.						
To Balance	3,839	18	9			
,, Savings Bank A/c	4	8	1			
				3,844	6	10
,, Interest received on Government Stock	176	19	6			
,, Savings Bank Interest ...	0	3	4			
				177	2	10
				£4,021	9	8

	£	s.	d.	£	s	d.
1922—September 30.						
By £2,000 S.A. Government Stock at 3¾%	1,997	10	0			
,, £800 S.A. Government Stock at 6%	800	0	0			
,, £500 S.A. Government Consolidated 3% Stock at cost ...	292	8	9			
,, £100 S.A. Government Stock at 5%	100	0	0			
,, £650 S.A. Government Stock at 5½%	650	0	0			
,, Savings Bank Account ...	4	8	1			
				3,844	6	10
,, Revenue Account				177	2	10
				£4,021	9	8

Audited and found correct—

W. CHAMPION HACKETT,
O. GLASTONBURY, A.A.I.S., } *Hon. Auditors.*

B. S. ROACH, *Hon. Treasurer.*

Adelaide, October 11, 1922.

DONATIONS TO THE LIBRARY

For the Year ended September 30, 1922.

Transactions, Journals, Reports, etc., presented by the respective governments, societies, and editors.

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LIST OF FELLOWS, MEMBERS, ETC.

AS EXISTING ON

SEPTEMBER 30, 1922.

Those marked with an asterisk have contributed papers published in the Society's Transactions.

Any change in address should be notified to the Secretary.

NOTE.—The publications of the Society will not be sent to those whose subscriptions are in arrears.

Date of Election

HONORARY FELLOWS.

1910. *Bragg, Sir W. H., K.B.E., M.A., D.Sc., F.R.S., Professor of Physics, University College, London (Fellow 1886).
1893. *Cossmann, M., 110, Faubourg Poissonnière, Paris.
1897. *David, Sir T. W. Edgeworth, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S., F.G.S., Professor of Geology, University of Sydney.
1905. Gill, Thomas, C.M.G., I.S.O., Glen Osmond.
1905. *Hedley, Chas., Assistant Curator, Australian Museum, Sydney.
1892. *Maiden, J. H., I.S.O., F.R.S., F.L.S., Director Botanic Gardens, Sydney, New South Wales.
1898. *Meyrick, E. T., B.A., F.R.S., F.Z.S., Tohrnhanger, Marlborough, Wilts, England.
1894. *Wilson, J. T., M.D., Ch.M., Professor of Anatomy, Cambridge University, England.
1912. *Tepper, J. G. O., F.L.S., Elizabeth Street, Norwood (Corresponding Member 1878, Fellow 1886).

CORRESPONDING MEMBERS.

1913. *Carter, H. J., B.A., Wahroonga, New South Wales.
1909. *Johncock, C. F., Clare.
1905. Thomson, G. M., F.L.S., Dunedin, New Zealand.
1908. *Woolnough, Walter George, D.Sc., F.G.S. (Fellow 1902).

FELLOWS.

1895. *Ashby, Edwin, F.L.S., M.B.O.U., Blackwood.
1917. Bailey, J. F., Director Botanic Garden, Adelaide.
1902. *Baker, W. H., F.L.S., King's Park.
1921. Birks, Melville, M.B., B.S., F.R.C.S., Hospital, Broken Hill.
1902. *Black, J. McConnell, 82, Brougham Place, North Adelaide.
1912. *Broughton, A. C., Young Street, Parkside.
1911. Brown, Edgar J., M.B., D.Ph., 3, North Terrace.
1883. *Brown, H. Y. L., 286, Ward Street, North Adelaide.
1916. *Bull, Lionel B., D.V.Sc., Laboratory, Adelaide Hospital.
1921. Burton, R. J., Fuller Street, Walkerville.
1922. Campbell, T. D., B.D.S., Adelaide Hospital.
1907. *Chapman, R. W., M.A., B.C.E., F.R.A.S., Professor of Engineering and Mechanics, University of Adelaide.

1922. Charles, Albert G., 88, Spring Street, Queenstown.
1904. Christie, W., 49, Rundle Street, Adelaide.
1895. *Cleland, John B., M.D., Professor of Pathology, University of Adelaide.
1907. *Cooke, W. T., D.Sc., Lecturer, University of Adelaide.
1916. Darling, H. G., Franklin Street, Adelaide.
1887. *Dixon, Samuel, Bath Street, New Glenelg.
1915. Dodd, Alan P., Prickly Pear Laboratory, Sherwood, Brisbane.
1921. Dutton, G. H., B.Sc., F.G.S., University of Adelaide.
1911. Dutton, H. H., B.A. (Oxon.), Anlaby.
1902. *Edquist, A. G., 2nd Avenue, Sefton Park.
1918. *Elston, A. H., F.E.S., Lefevre Terrace, North Adelaide.
1917. *Fenner, Chas. A. E., D.Sc., F.G.S., Education Department, Adelaide.
1914. Ferguson, E. W., M.B., Ch.M., Gordon Road, Roseville, Sydney.
1919 Glastonbury, O., Adelaide Cement Co., Brookman Buildings.
1904. Gordon, David, c/o D. & W. Murray, Gawler Place, Adelaide.
1880. *Goyder, George, A.M., F.C.S., Gawler Place, Adelaide.
1910. *Grant, Kerr, M.Sc., Professor of Physics, University of Adelaide.
1922. Grant, R. L. T., M.B., B.S., M.R.C.P., University of Adelaide.
1904. Griffith, H., Brighton.
1916. Hackett, W. C., 35, Dequetteville Terrace, Kent Town.
1922. Hale, H. M., Molesworth Street, North Adelaide.
1922. *Ham, William, F.R.E.S., University of Adelaide.
1916. Hancock, H. Lipson, A.M.I.C.E., M.I.M.M., M.Am.I.M.E., Kennedya, Wallaroo Mines.
1896. Hawker, E. W., F.C.S., East Bungaree, Clare.
1883. *Howchin, Professor Walter, F.G.S., "Stonycroft," Goodwood East.
1918. Ising, Ernest H., Loco. Department, Islington
1912. Jack, R. L., B.E., Assistant Government Geologist, Adelaide.
1923. James, Thomas, M.R.C.S., 9, Watson Avenue, Rose Park.
1918. Jennison, Rev. J. C., Crocodile Islands, Northern Territory.
1910. *Johnson, E. A., M.D., M.R.C.S., 295, Pirie Street, Adelaide.
1921. *Johnston, Professor T. Harvey, M.A., D.Sc., University of Brisbane.
1920. *Jones, F. Wood, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., Professor of Anatomy, University of Adelaide.
1918. Kimber, W. J., Gaza.
1915. *Laurie, D. F., Agricultural Department, Victoria Square.
1897. *Lea, A. M., F.E.S., South Australian Museum, Adelaide.
1884. Lendon, A. A., M.D. (Lond.), M.R.C.S., Lecturer in Obstetrics, University of Adelaide, and Hon. Physician, Children's Hospital, North Adelaide.
1922. Lendon, Alan H., North Terrace.
1922. Lendon, Guy A., M.B., B.S., M.R.C.P., North Terrace.
1888. *Lower, Oswald B., F.Z.S., F.E.S., Broken Hill, New South Wales.

1922. Madigan, C. T., B.A., B.Sc., University of Adelaide.
1914. Mathews, G. M., F.R.S.E., F.L.S., F.Z.S., Foulis Court, Fair Oak, Hants, England.
1905. *Mawson, Sir Douglas, D.Sc., B.E., Professor of Geology, University of Adelaide.
1920. Mayo, Herbert, LL.B., Brookman Buildings, Grenfell Street.
1919. Mayo, Helen M., M.B., B.S., 17, Melbourne Street, North Adelaide.
1920. McGilp, John Neil, Napier Terrace, King's Park.
1907. Melrose, Robert Thomson, Mount Pleasant.
1897. *Morgan, A. M., M.B., Ch.B., 46, North Terrace, Adelaide.
1921. Moulden, Owen M., M.B., B.S., Broken Hill.
1922. *Nobes, Edith D., B.Sc., University of Adelaide.
1913. *Osborn, T. G. B., D.Sc., Professor of Botany, University of Adelaide.
1886. Poole, W. B., 6, Rose Street, Prospect.
1908. Pope, William, Eagle Chambers, Pirie Street.
1907. *Pulleine, R. H., M.B., 3, North Terrace, Adelaide.
1916. Ray, William, M.B., B.Sc., Victoria Square, Adelaide.
1885. *Rennie, Edward H., M.A., D.Sc. (Lond.), F.C.S., Professor of Chemistry, University of Adelaide.
1911. Roach, B. S., Education Department, Flinders Street, Adelaide.
1919. *Robertson, Professor T. B., University of Adelaide.
1905. *Rogers, R. S., M.A., M.D., Hutt Street, Adelaide.
1869. *Rutt, Walter, C.E., College Park, Adelaide.
1891. Selway, W. H., Treasury, Adelaide.
1922. *Samuel, Geoffrey, B.Sc., University of Adelaide.
1920. Simpson, A. A., C.M.G., Lockwood Road, Burnside.
1906. Snow, Francis H., National Mutual Buildings, King William Street.
1910. *Stanley, E. R., Government Geologist, Port Moresby, Papua.
1922. Sutton, J., Fullarton Road, Netherby.
1921. *Tiegs, Oscar W., M.S., University of Adelaide.
1897. *Torr, W. G., LL.D., M.A., B.C.L., Brighton, South Australia.
1894. *Turner, A. Jefferis, M.D., F.E.S., Wickham Terrace, Brisbane, Queensland.
1878. *Verco, Sir Joseph C., M.D. (Lond.), F.R.C.S., North Terrace, Adelaide.
1914. *Waite, Edgar R., F.L.S., Director South Australian Museum.
1912. *Ward, Leonard Keith, B.A., B.E., Government Geologist, Adelaide.
1920. Weidenbach, W. W., A.S.A.S.M., Glencoola, Glen Osmond.
1904. Whitbread, Howard, c/o A. M. Bickford & Sons, Currie Street, Adelaide.
1912. *White, Captain S. A., C.M.B.O.U., "Wetunga," Fulham, South Australia.
1920. *Wilton, Professor J. R., D.Sc., University of Adelaide.

Associate.

1904. Robinson, Mrs. H. R., "Las Conchas," Largs Bay, South Australia.

APPENDIX.

FIELD NATURALISTS' SECTION

OF THE

Royal Society of South Australia (Incorporated).

THIRTY-NINTH ANNUAL REPORT OF THE COMMITTEE

FOR THE YEAR ENDED SEPTEMBER 26, 1922.

The Committee has pleasure in recording a year of progress and work well done, activities in many branches of science being well maintained.

Last year's membership was recorded as 132, and there have been 63 new members elected, and several resignations and deaths during the twelve months, so that our present membership totals 183. We have every reason to be gratified at this large increase, which it is hoped will continue.

EXCURSIONS.—On the whole, the excursions have been well attended and interesting information has been given by the various leaders. The subjects have been as follows:—Forestry, Geology and Minerals, Zoology, Shore Life, Physiography, Shells, Botany, Nature Study, Pond Life, Dredging, Botanic Gardens.

LECTURES.—The Lectures have been of the usual high character, and we are much indebted to those who gave them. The subjects have been as follows:—Aquaria, Artesian Waters, Native Camps, Conchology, Mushrooms, Entomology, Ooldea, "Through Australia," Crystals, Recently Introduced Weeds, and Plant Curiosities. The attendances have been generally good, and quite a large number of visitors have been present. During the year an innovation was introduced by which lectures dealing with the elementary phases of natural science were given. More lectures of this kind are needed, and the Committee intends giving attention to this for the next programme.

EXHIBITS.—Numbers of specimens were brought to the meetings and were always interesting. It cannot be said that this item has been given too much prominence, and it is hoped that more members will avail themselves of the invitation to bring exhibits at every meeting.

WILD FLOWER SHOW, 1921.—A very successful show was held on September 23 and 24, and the net proceeds amounted to £69.

"THE SOUTH AUSTRALIAN NATURALIST."- Our paper has been published quarterly and has been the means of maintaining interest in our Section.

VERNACULAR PLANT NAMES.—The Sub-committee appointed has not met during the year. It is understood that the Victorian Field Naturalists' Club is publishing a new flora of that State, in which common names will be shown. It may be possible to include popular names in the new Flora of South Australia now being prepared.

FLOWER SHOWS IN OTHER STATES.—At our previous flower shows we have been fortunate in receiving big consignments from other States, and we have reciprocated as far as possible. This year parcels of native flowers have been sent as follows:—(1) To Melbourne, Victorian F.N. Club's Exhibition, June 20. (2) To Sydney, Naturalists' Society of New South Wales Exhibition on September 7 and 8. (3) To Broken Hill, Barrier Field Naturalists' Club Wild Flower Show on September 9. We intend sending wild flowers to the Queensland Naturalists' Club, September 30, and Victorian Field Naturalists' Club, October 3. It has also been arranged to make an exhibit of wild flowers at the Sweet Pea Exhibition, in the Adelaide Town Hall, on September 23, and at the Horticultural and Floricultural Society's Flower Show on October 27. Mrs. Page, of Myponga, has been a great help in this connection.

NEWSPAPER REPORTS.—We are grateful to the daily papers for inserting our reports of excursions and lectures, and to *The Register*, in particular, for its sympathetic attitude generally towards Nature subjects.

OBITUARY.—It is our sad duty to record the death of several members during the term as follows:—Mr. G. De Caux, a young man who was deeply interested in Nature, and who had made a special study of orchids, and was the first to discover in South Australia the Duck Orchid *(Caleana major)*. He was studying for the ministry and gave promise of exceptional ability. Mr. Jas. Aitken died recently at an advanced age, and was known to our Section for his wide knowledge of natural history. Mr. A. M. Drummond was a member for a number of years, and through his genial personality he was well liked. His interests in natural history were of a general character.

WM. HAM, *Chairman.*

ERNEST ISING, *Hon. Secretary.*

THIRTY-THIRD ANNUAL REPORT OF THE NATIVE FAUNA AND FLORA PROTECTION COMMITTEE

FOR THE YEAR ENDED SEPTEMBER 20, 1922.

Two meetings were held during the year.

It is to be regretted that the proposed Trees and Roadsides Bill, referred to in last year's report, was defeated in Parliament

The Minister of Industry was approached by the Chairman in terms of Mr. Bristow's request to have a Reserve for Kangaroos and Emus in the Flinders Range, but he was advised that the Ministry were not prepared to take notice of the application without its being consented to by the landholders affected. Mr Bristow was accordingly advised to get up a petition by those concerned in order to obtain what he desired

A report was made to the Minister of Industry drawing attention to owls being kept in captivity by a dealer in this city. Action was taken, and we were advised later that the birds had been liberated by the dealer.

The Minister was also informed that opossums were being shot near Urrbrae and Netherby. The police were instructed to investigate, but owing to the lapse of time they were unable to secure the offender. The Minister, therefore, requests that prompt intimation be given to his Department in any future breaches of the regulations of the Animal and Bird Protection Act.

Notification was sent that shooting at ducks appeared to be taking place on the Thorndon Park Reservoir. Action was taken by the Department to have that stopped, and the Waterworks and Sewers Department, under whose control the Reservoir is placed, was notified.

FLINDERS CHASE.—The situation with regard to this is progressing, and matters of improvement are now, it is understood, before the Board. On August 18 last the Chairman delivered a lecture at the Town Hall, at which a collection was taken up in aid of this Chase and resulted in a fair sum being handed over to the Board.

Through business requirements, Mr. J. Neil McGilp relinquished the office of Hon. Secretary, and a very hearty vote of thanks was passed by the members of the Committee for his past services.

J. SUTTON, *Hon. Secretary.*

September 9, 1922.

Field Naturalists' Section of the Royal Society.

Statement of Receipts and Expenditure for Year ended September, 1922.

General Account.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
By Credit Balance brought forward	0	11	3	To Refund to Excursion Account	18	3	10
,, Profit from Wild Flower Show	69	2	0	,, Printing	43	7	8
,, Members' Subscriptions	50	13	9	,, Hire of Hall and Lantern	9	9	10
,, Grant from Royal Society	50	0	0	,, Postages	20	5	6
,, Sale of Badges	2	15	0	,, Stationery	2	7	3
,, Sale of Magazine	1	11	8	,, Library Books	6	3	5
,, Sale of Photos.	0	4	0	,, Members' Subscriptions paid to Royal Society	51	5	0
,, Bank Interest	1	15	5	,, Donation to Flora and Fauna Board	10	10	0
				,, Expenses Flora and Fauna Society	3	2	0
				,, Advertising	1	2	6
	£176	13	1	,, Balance carried forward	10	16	1
Balance brought forward, £10 16s. 1d.					£176	13	1

Excursion Account.

	£	s.	d.		£	s.	d.
By Credit Balance brought forward	0	1	5	To Hire of Motors	81	0	0
,, Refund from General Account	18	3	10	,, Refreshments	0	16	9
,, Excursion Fares	82	4	0	,, Hire of Steam Tug	5	17	6
				,, Gratuity to Sailors	1	0	0
				,, Repairs to Dredge	0	17	0
				,, Balance carried forward	10	18	0
	£100	9	3		£100	9	3

Audited and found correct,

Walter D. Reed, F.O.P.A., } *Auditors.*
Alec J. Morison,

Beavis B. Beck, *Hon. Treasurer.*

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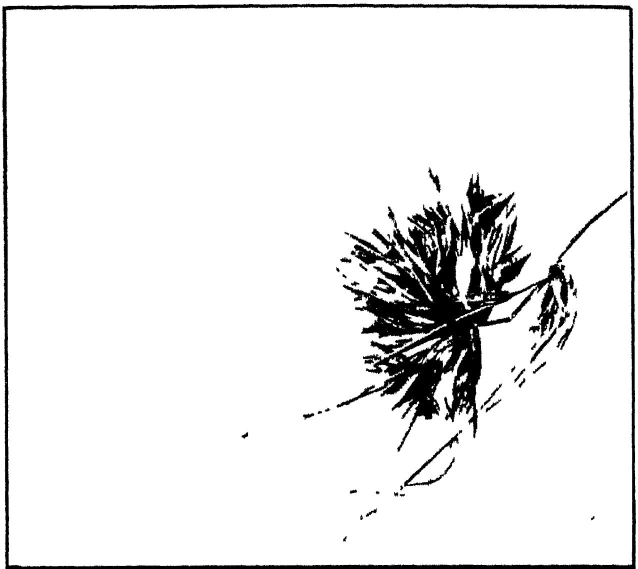

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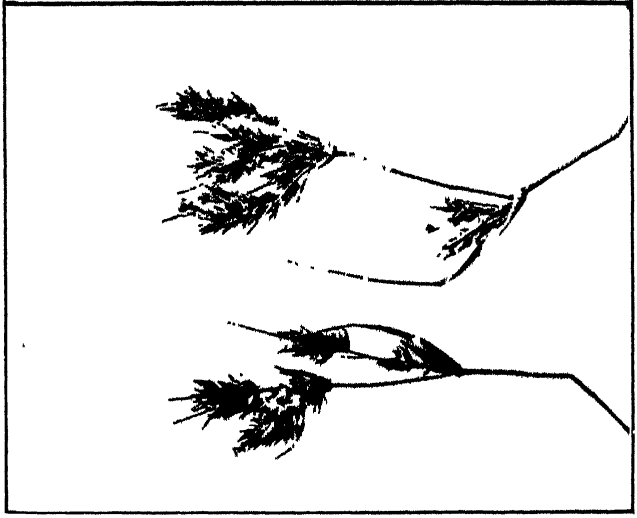

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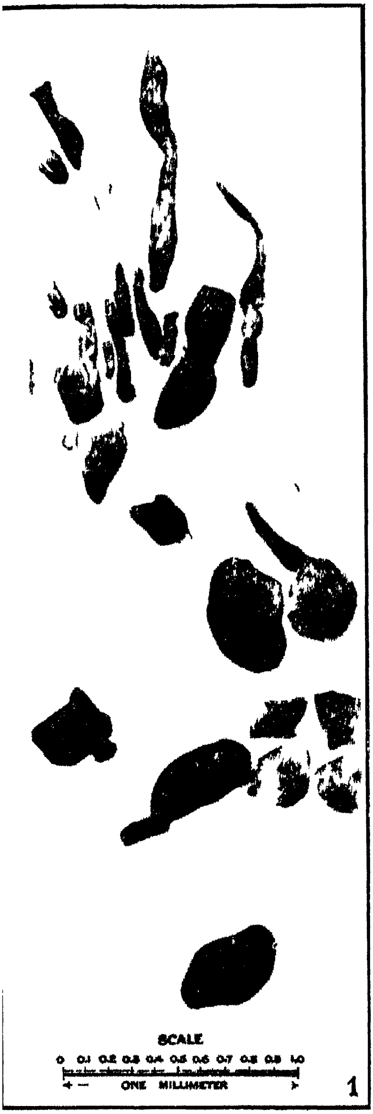
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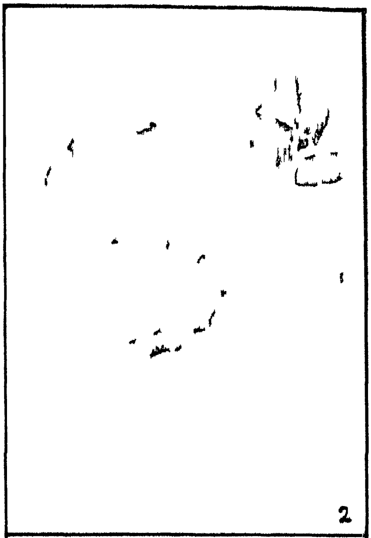

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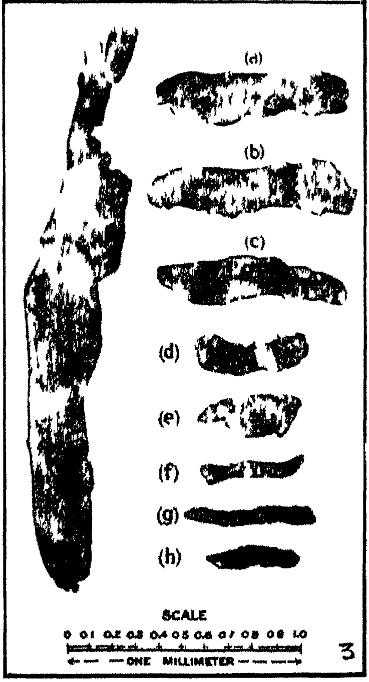
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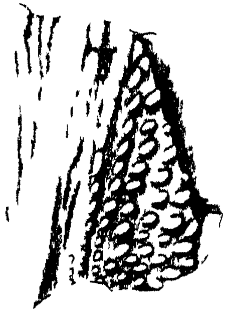

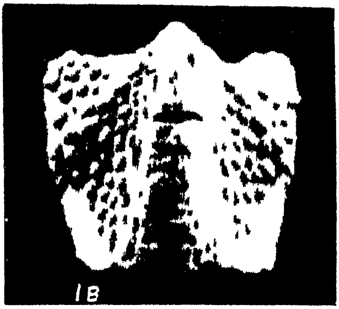

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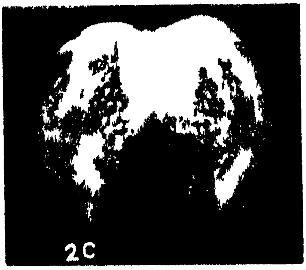

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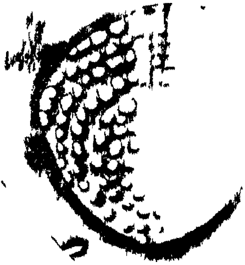

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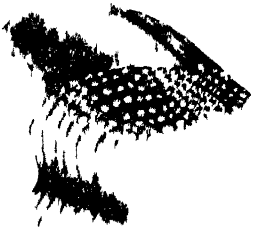

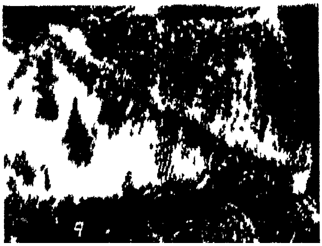

9

GEOLOGICAL SKETCH-SECTION ACR

BY WALTER HOW

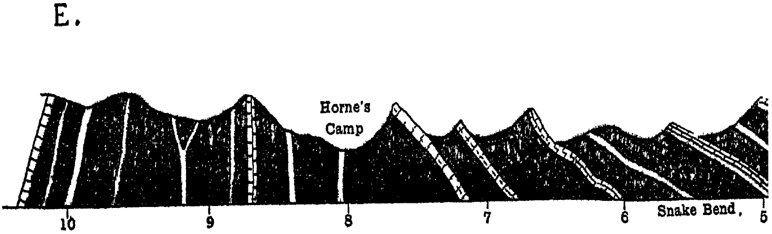

Fig. 1.—GEOLOGICAL SKETCH SECTION OF OUTCROPS FROM THE MOU

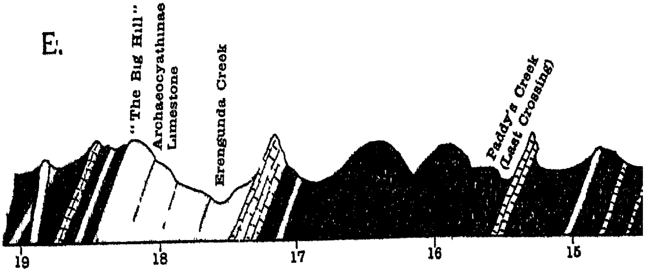

Fig 2.—GEOLOGICAL SKETCH-SECTION FROM BLINMAN

Red Sandstones and Variously Coloured Shales	▨
Quartzites and Sandstones	▦
Purple Slates and Shales	■
Limestones of various kinds	□
Igneous Basic Dykes	▯

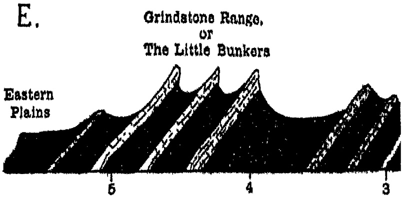

Fig. 3 —GEOLOGICAL SKETCH-SECTION FROM

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OSS THE FLINDERS RANGES.

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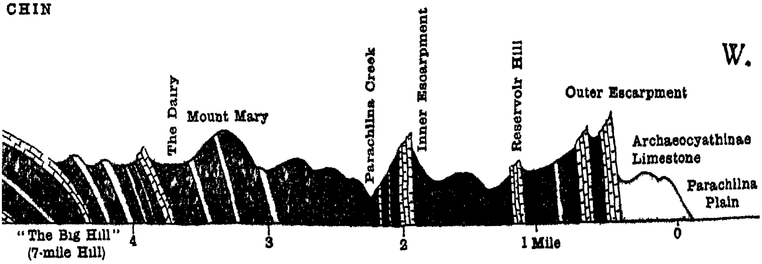
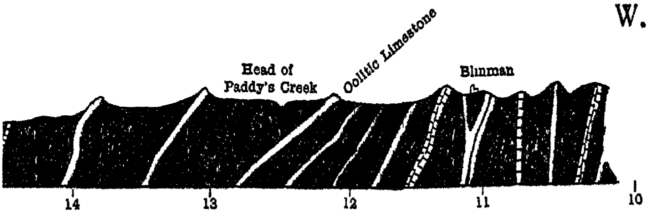
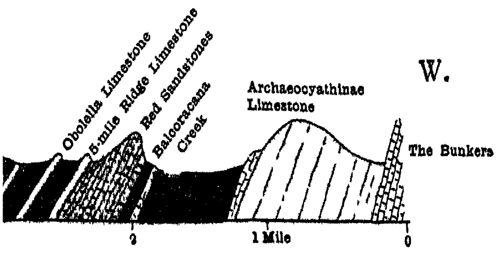


TH OF THE PARACHILNA GORGE TO THE VICINITY OF BLINMAN.

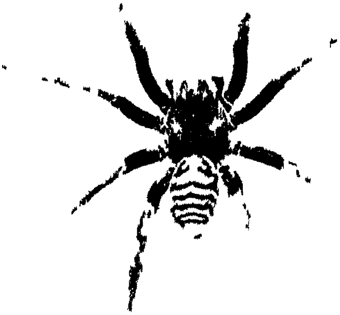


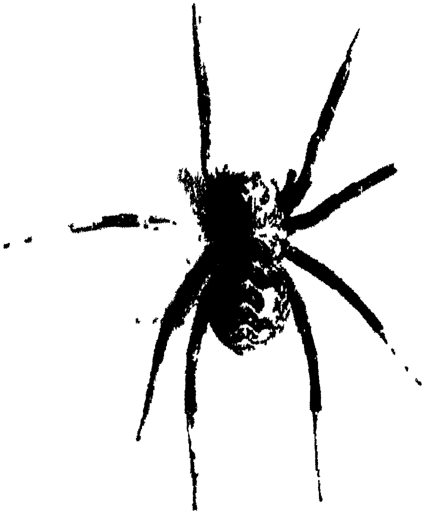
TO THE NORTHERN SIDE OF THE ERENGUNDA CREEK.



THE BUNKERS TO THE EASTERN PLAINS.

Lycosa skeeti, n. sp. Nat. size





Lycosa perinflata, n. sp. Nat. size

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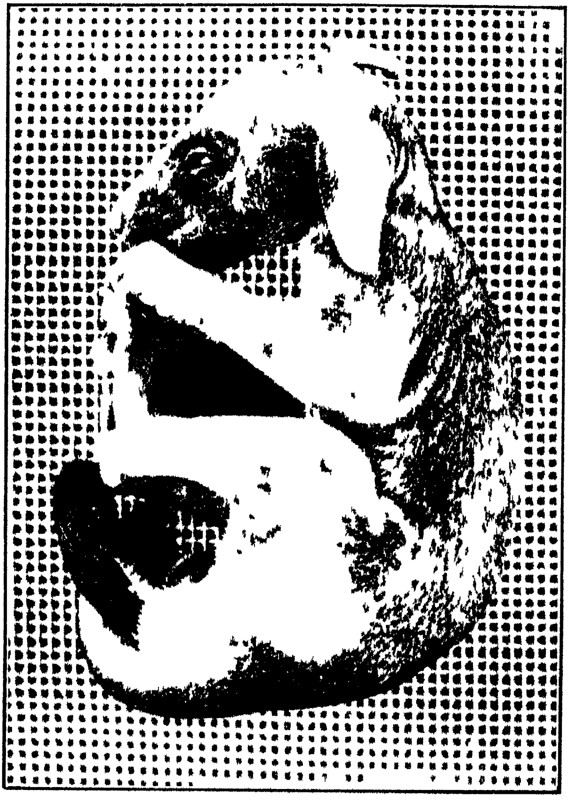

Pseudochirops dahli, Col

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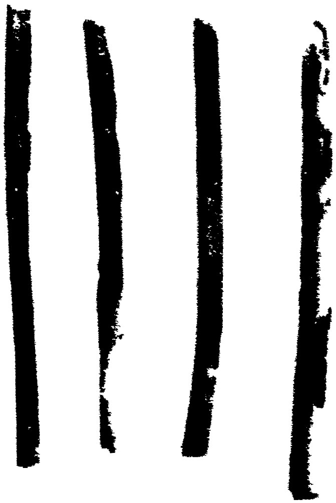

Fig 1 *Trametes lutbinis*

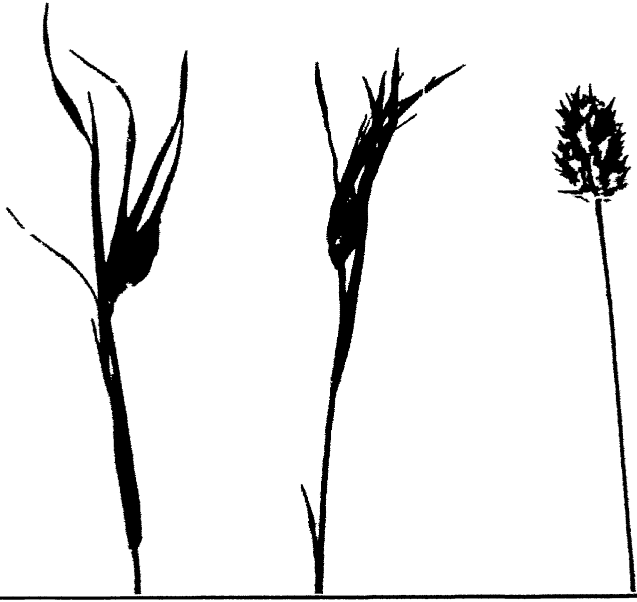

Fig 2 *Ustilago Tepperi*

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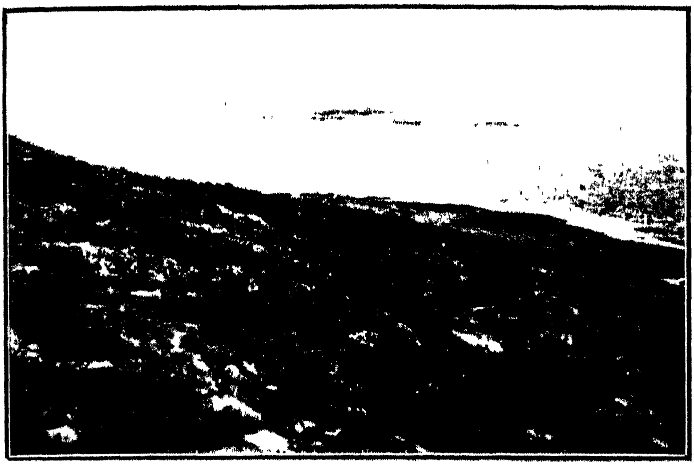

Fig. 1. Islet off Eastern Franklin, showing the granitic platform with a small cap of consolidated sandstone at one end.

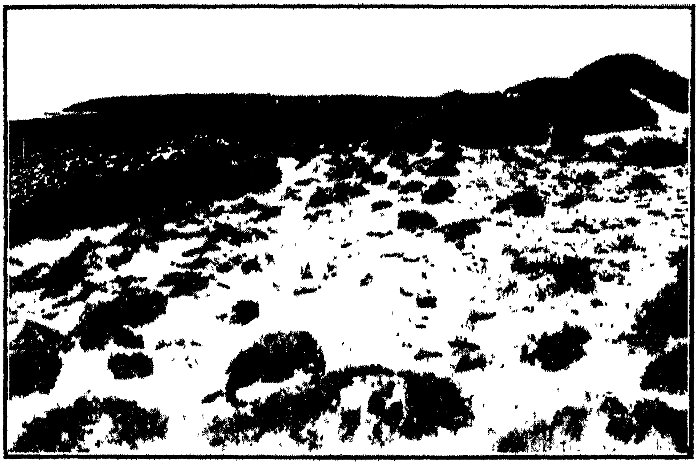

Fig. 2. Area on south coast of Eastern Franklin, showing sand drifting away from and exposing travertine pavement. The blown sand is held by *Nitraria Schoeberi.*

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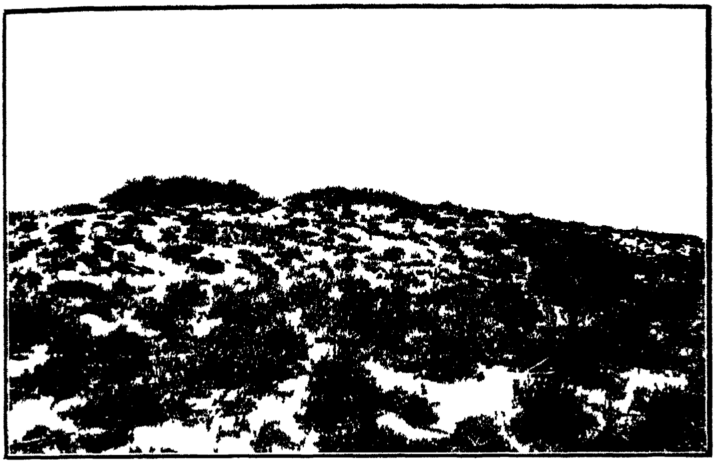

Fig 1 Travertine knoll rising a few feet above general level of roof

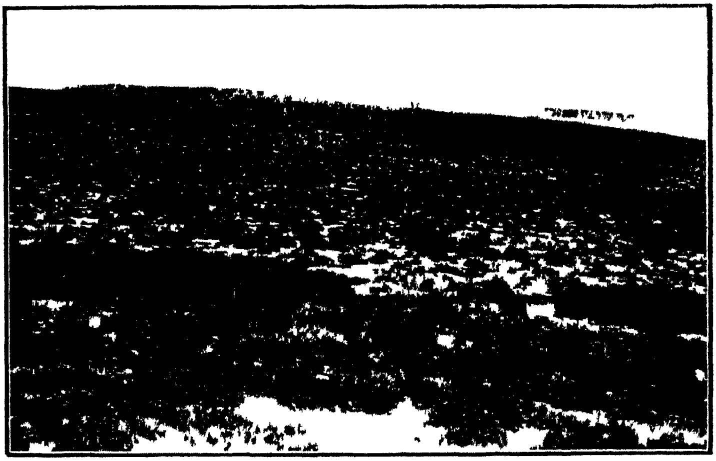

Fig 2 General view on roof looking west from the knoll seen in previous figure

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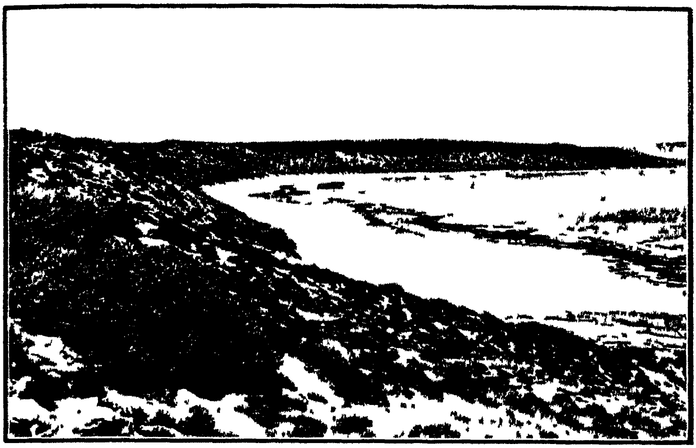

Fig 1 Cliff vegetation on north coast Eastern Franklin

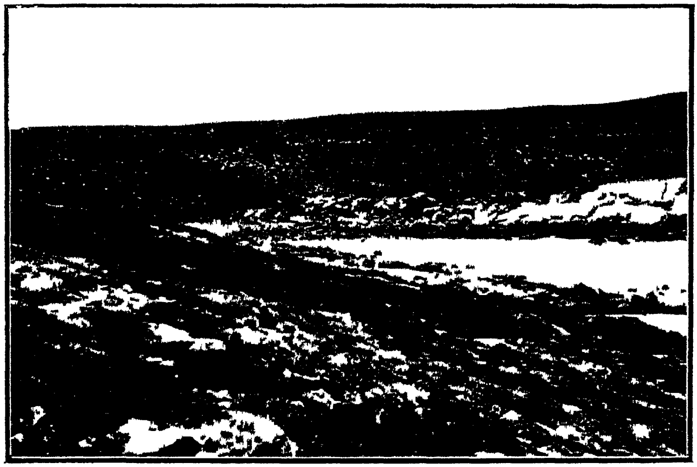

Fig 2 Cove on south coast Western Franklin

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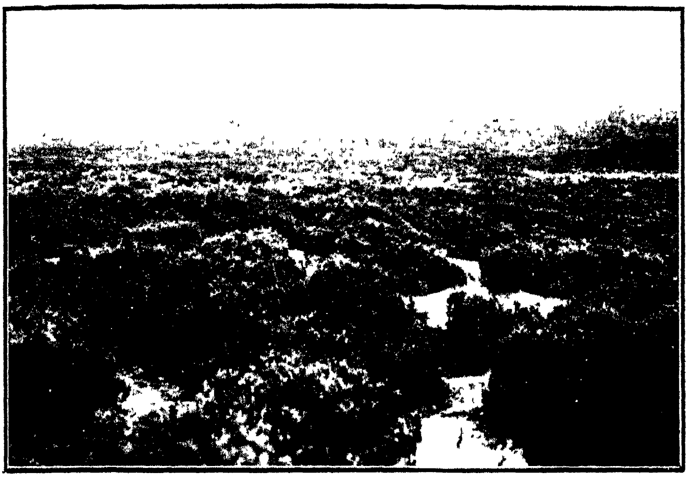


Fig. 1. *Rhagodia crassifolia* shrubland on roof of Western Franklin.

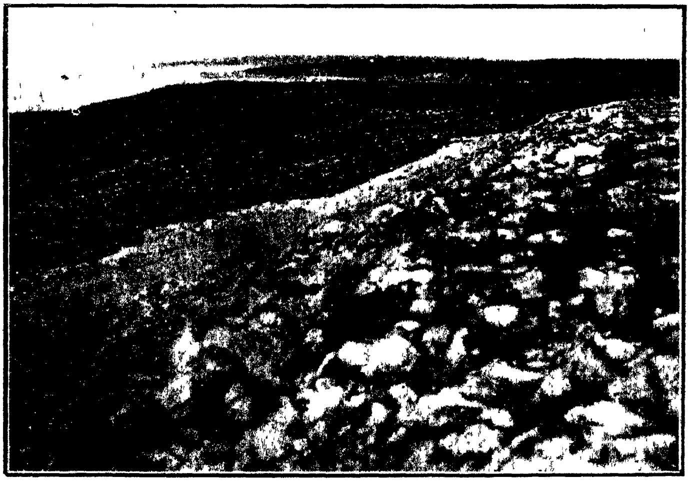
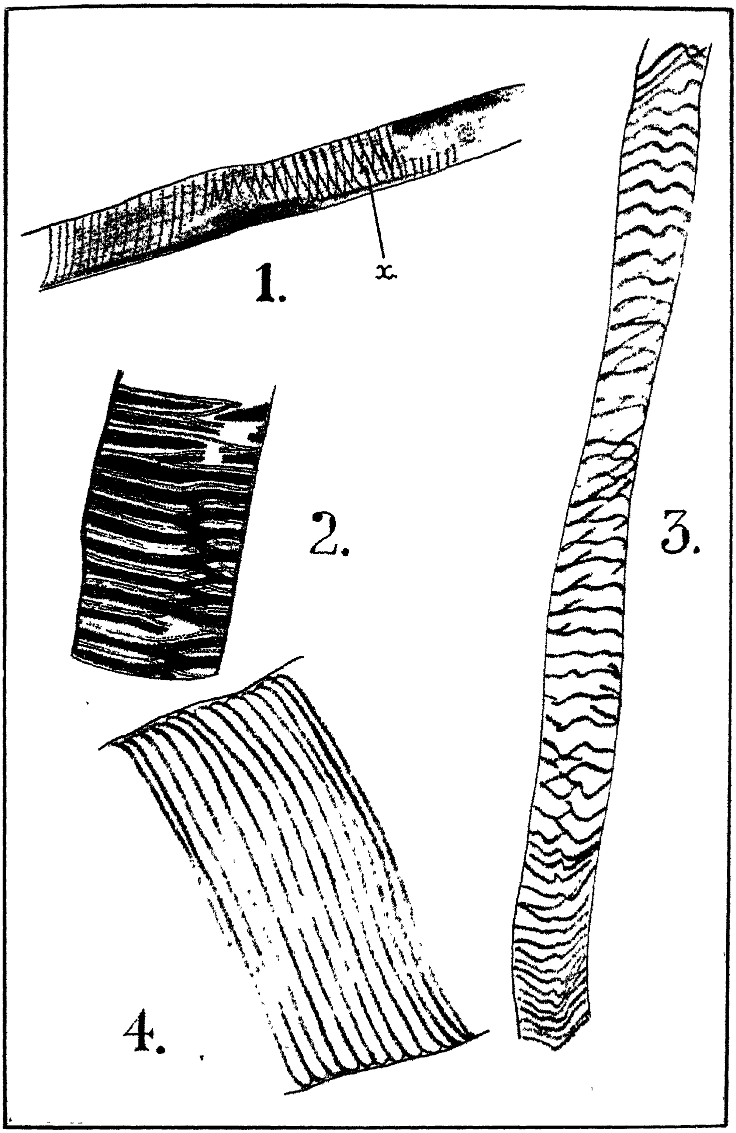


Fig. 2. Recent blow-out exposing travertine pavement in foreground. The vegetation beyond is of the unstable type on sand.



Striations of Voluntary Muscle Fibres in double spirals.

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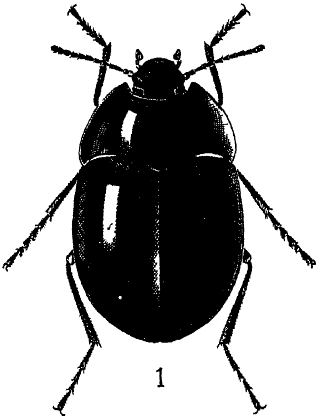

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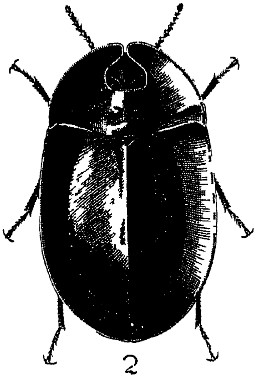

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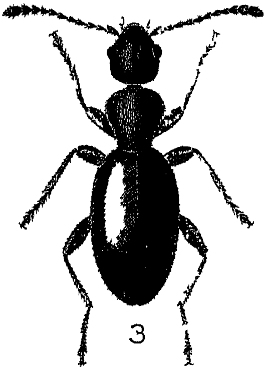

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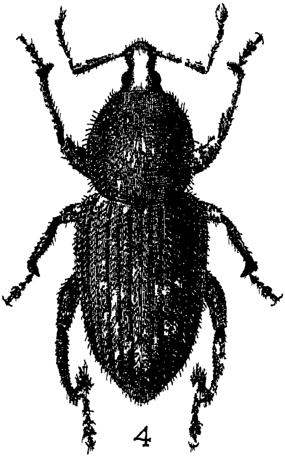

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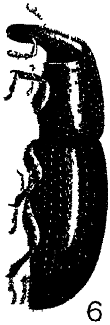

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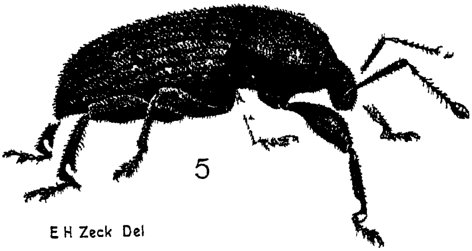

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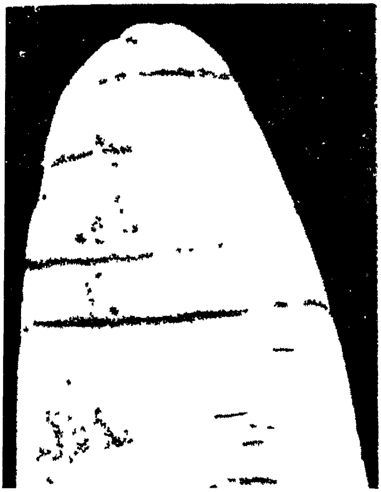
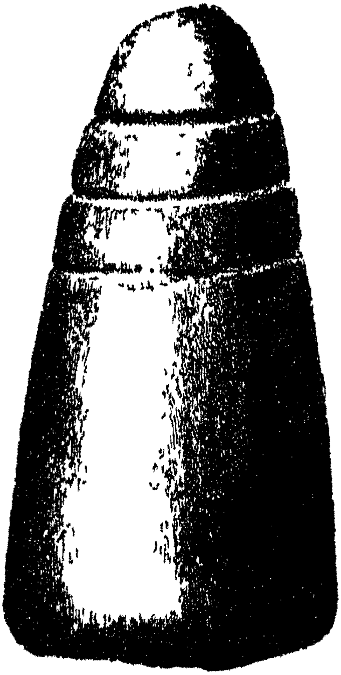


Fig 1



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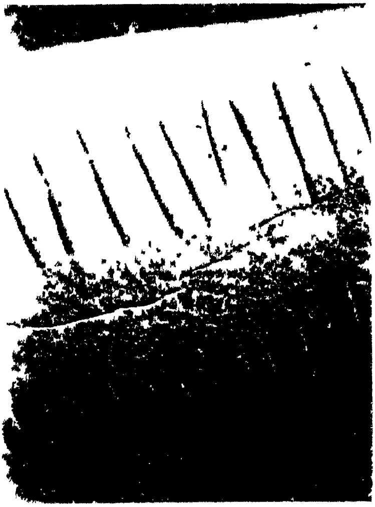

Fig 3

Fig 1 Upper third of cylindro-conical made of kopi showing "praeputial rings" of Etheridge Nat size

Fig 2 Phallus or priapus, from Schliemann Ilios, p 452, No 682 for comparison with fig. 1

Fig 3 Portion of cylindro-conical of slate, showing "tally marks"

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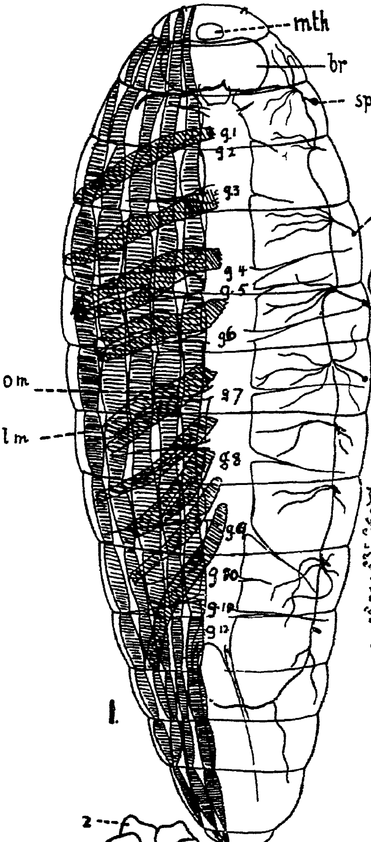
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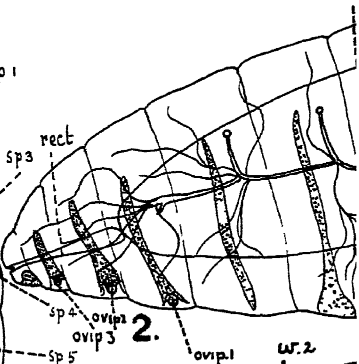
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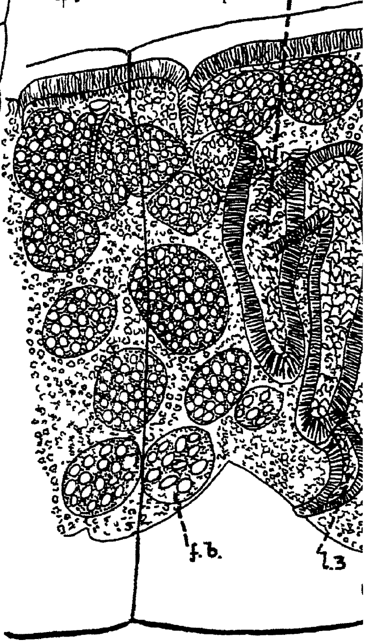
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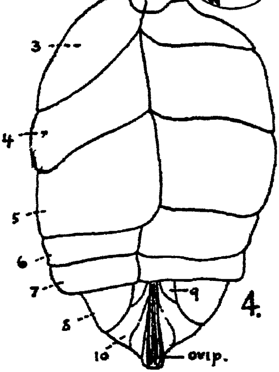
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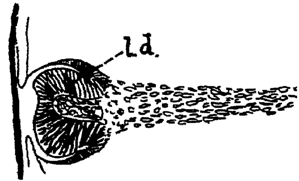
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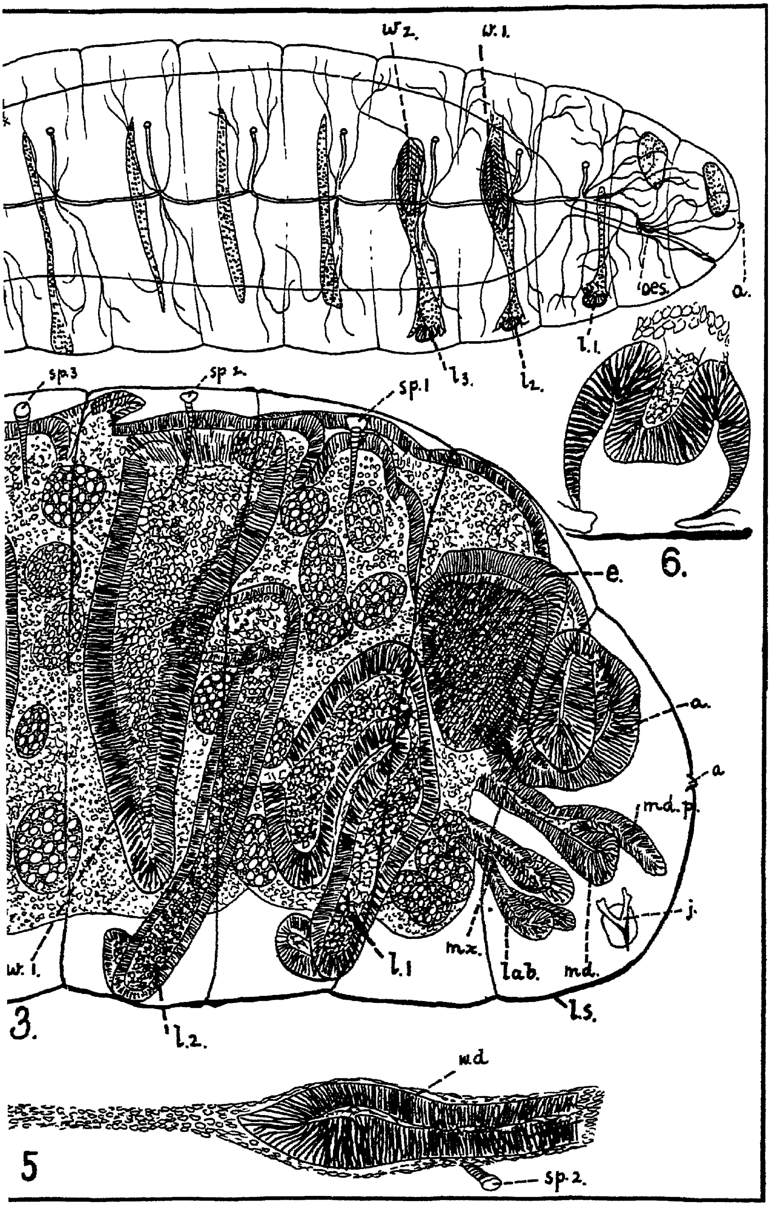

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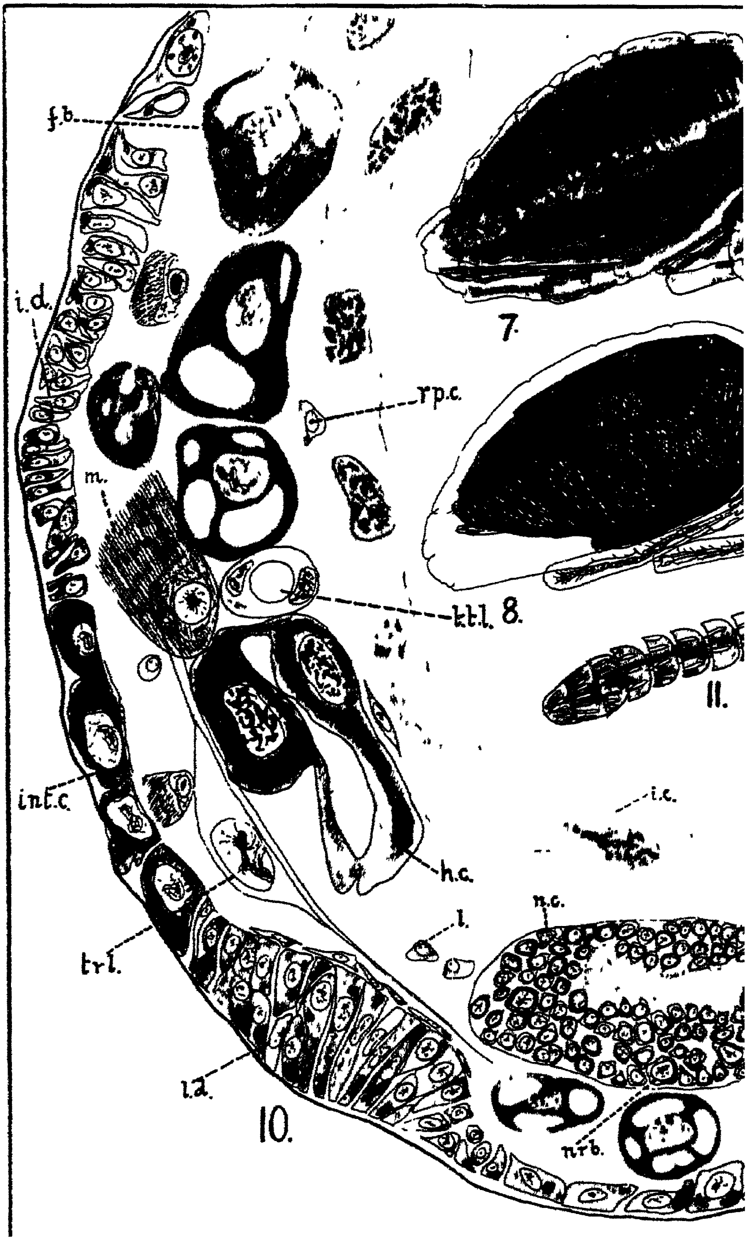
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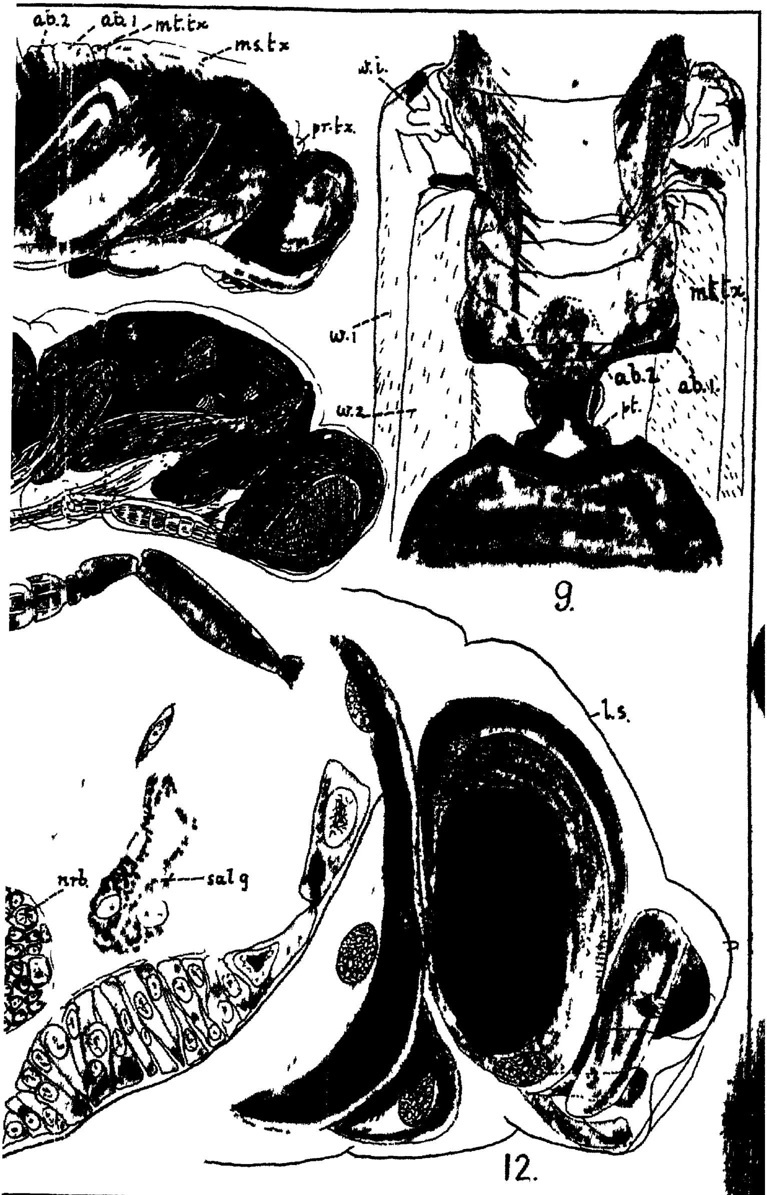

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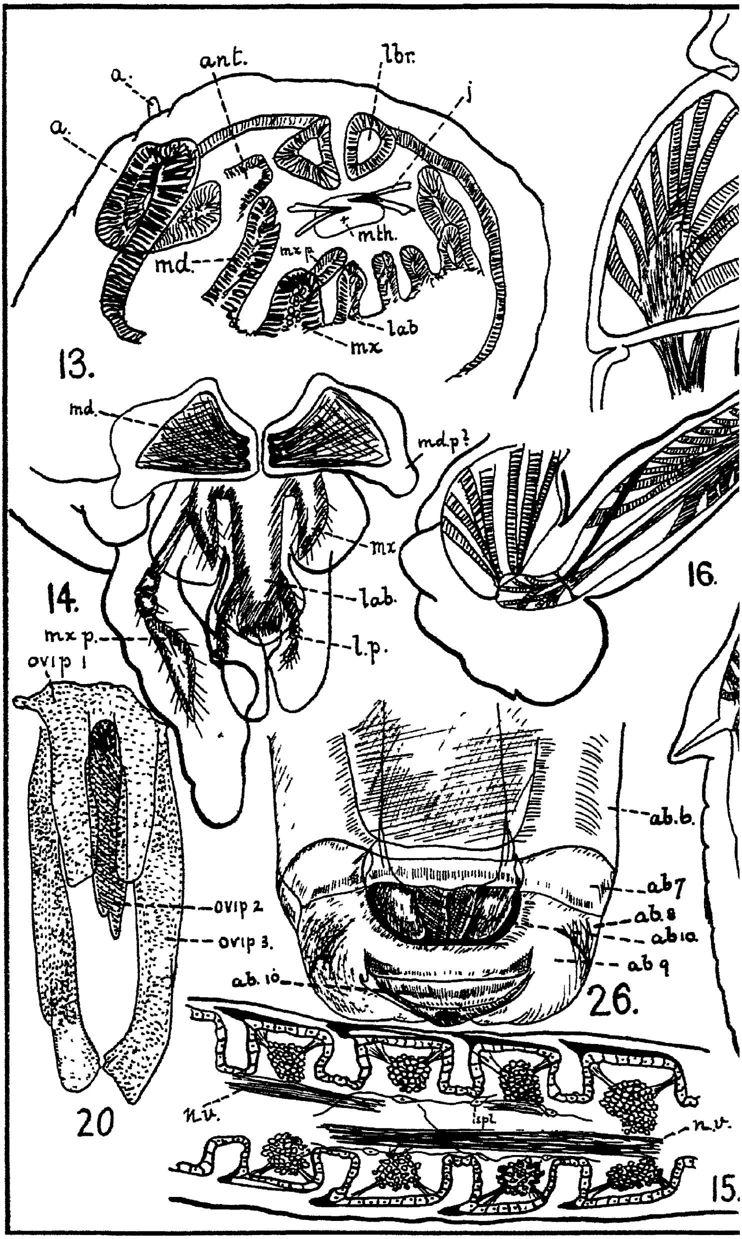
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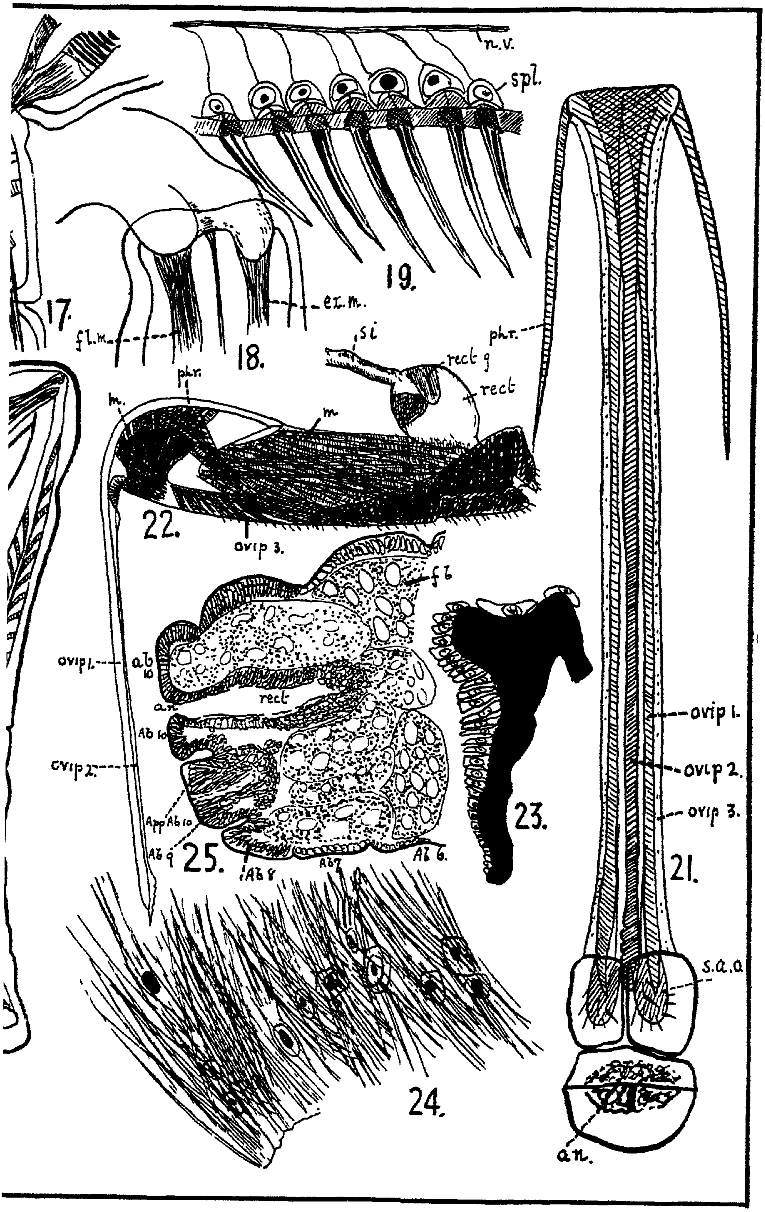

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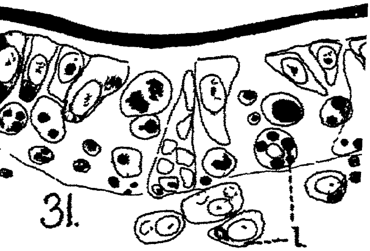

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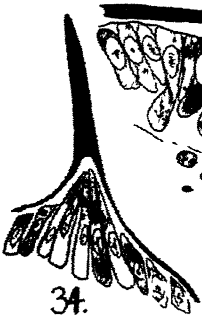

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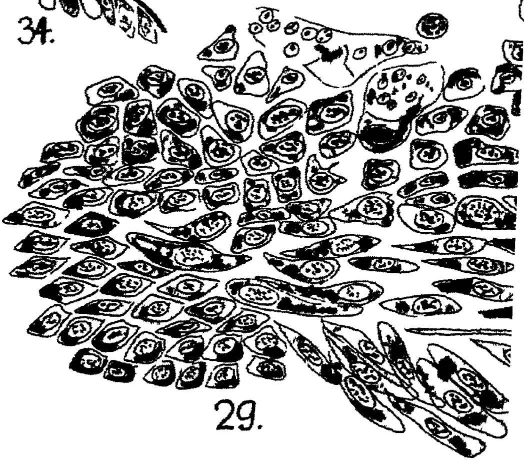

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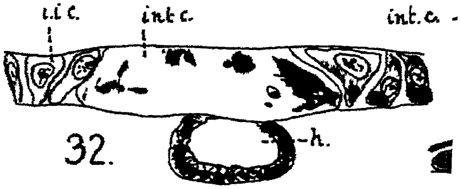

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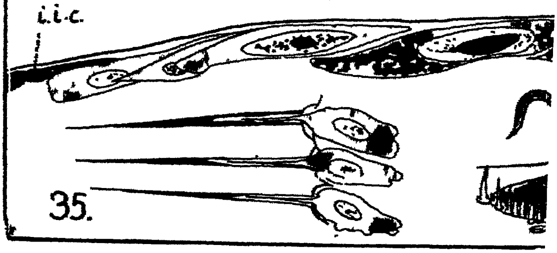

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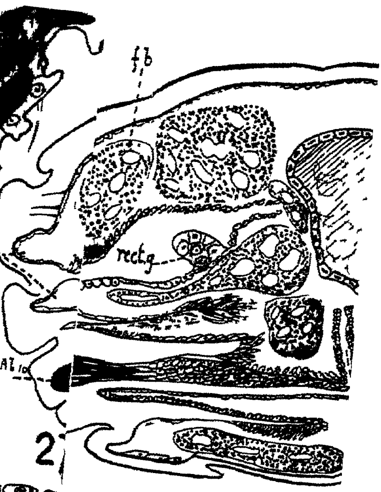

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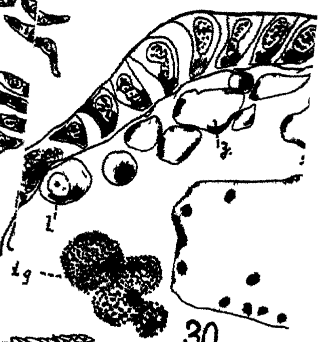

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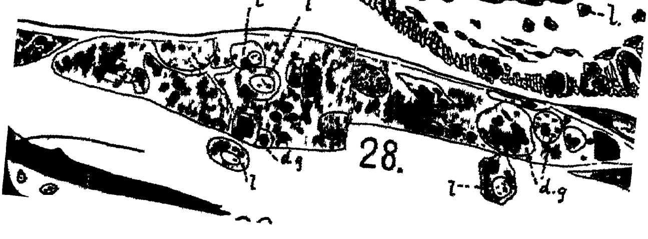

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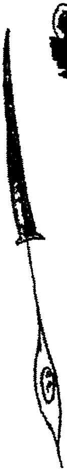

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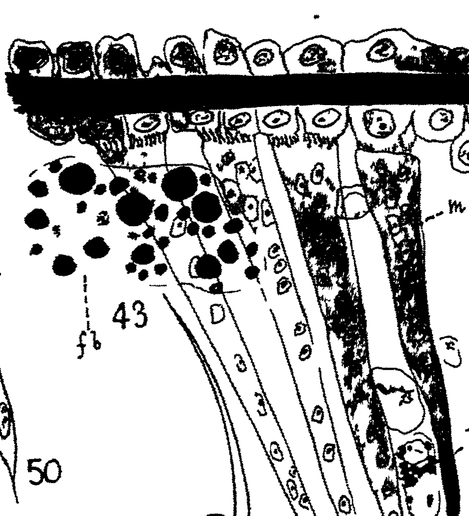

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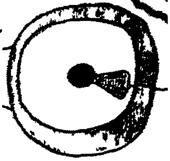

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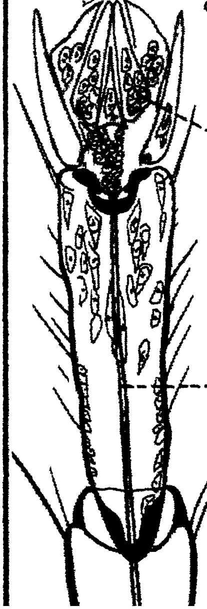

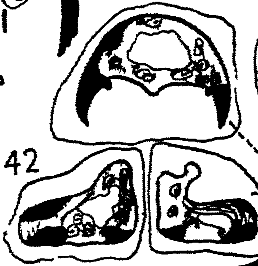

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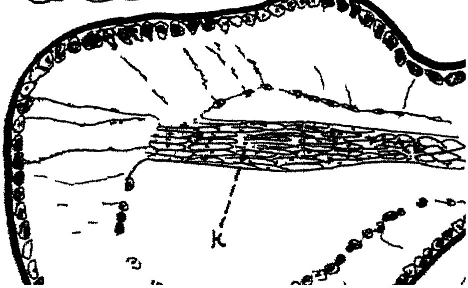

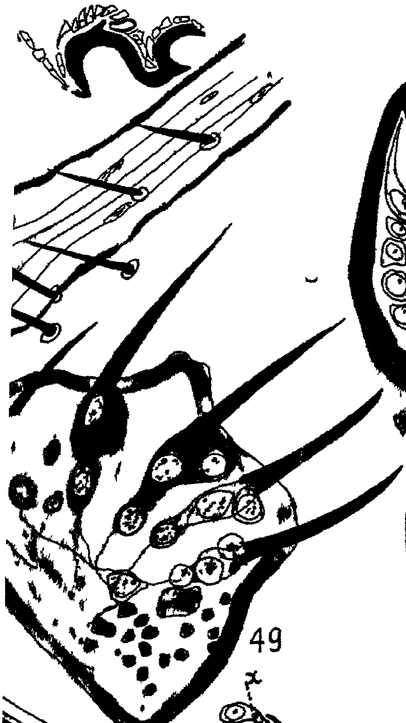

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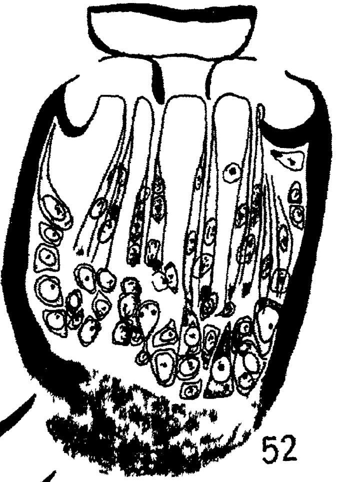

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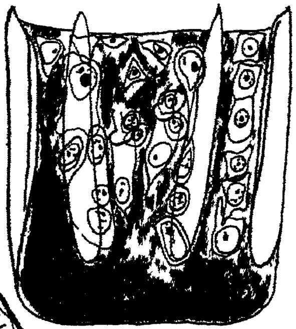

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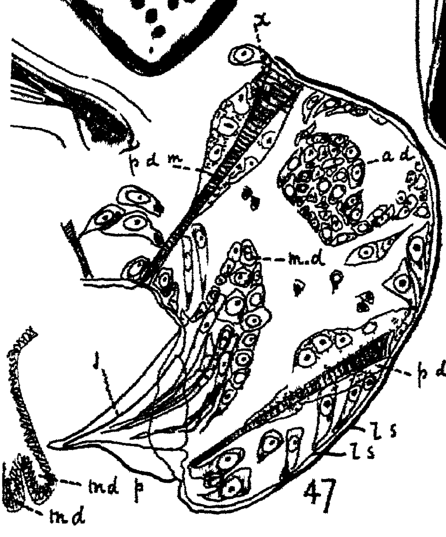

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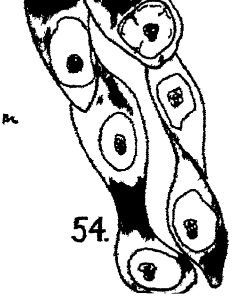

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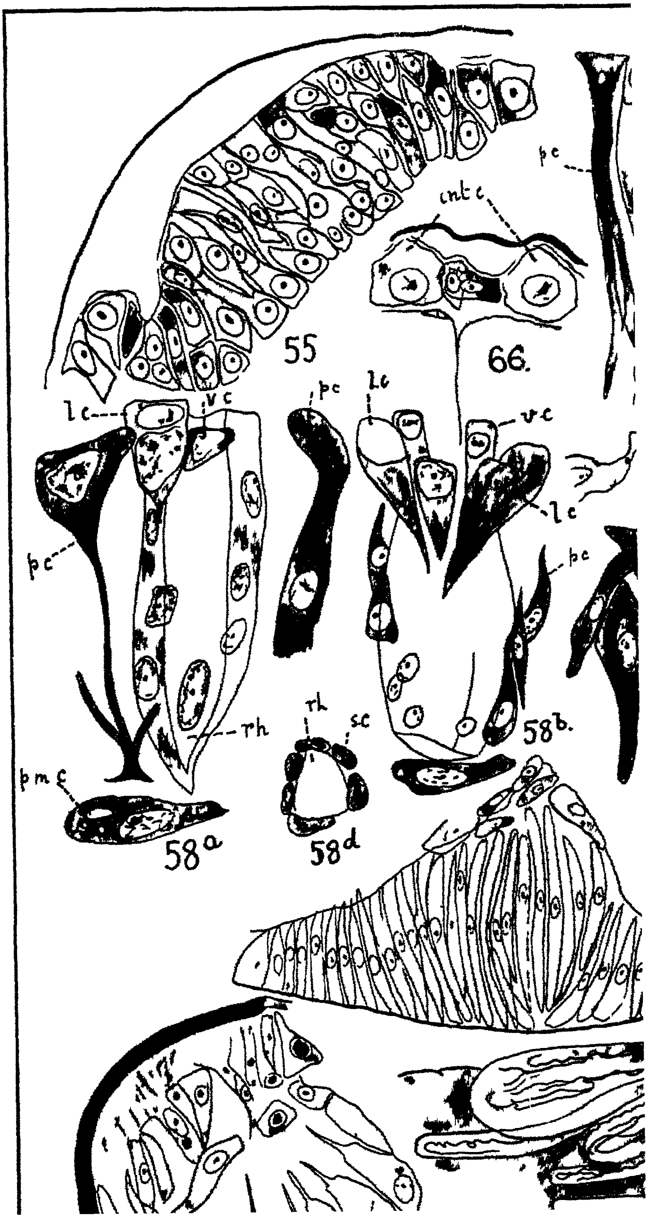
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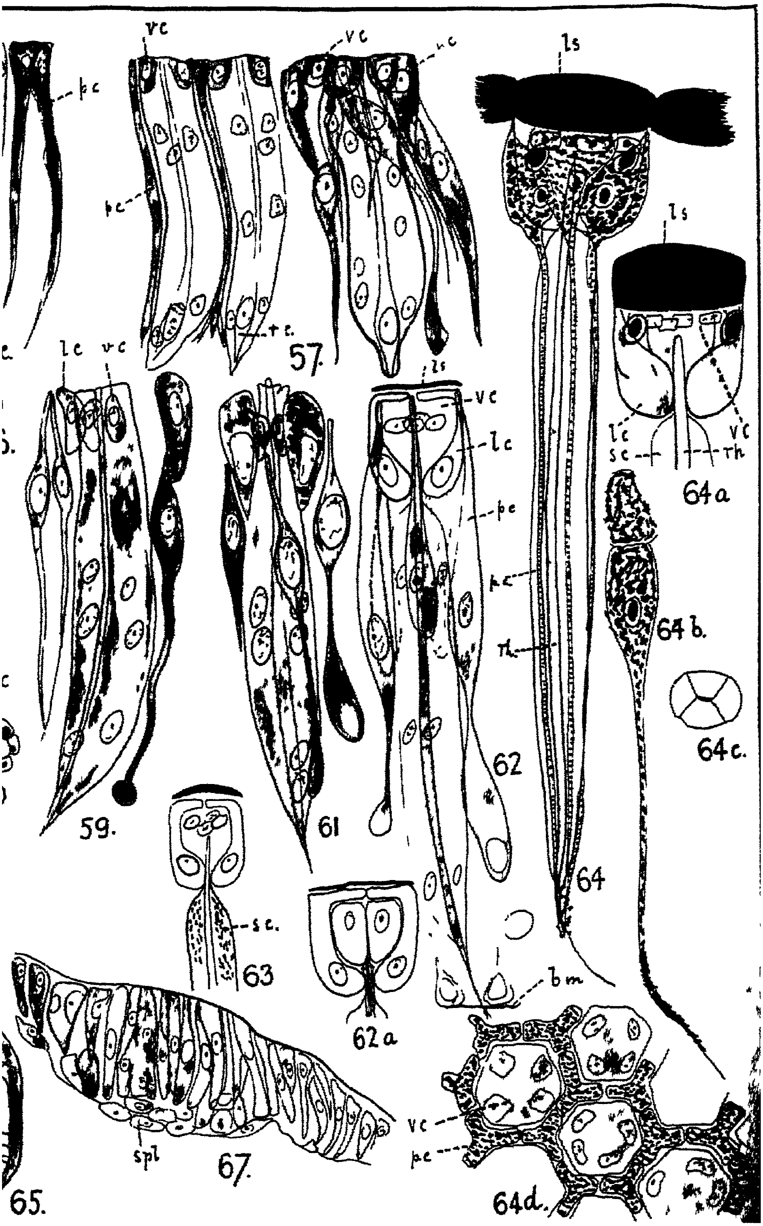
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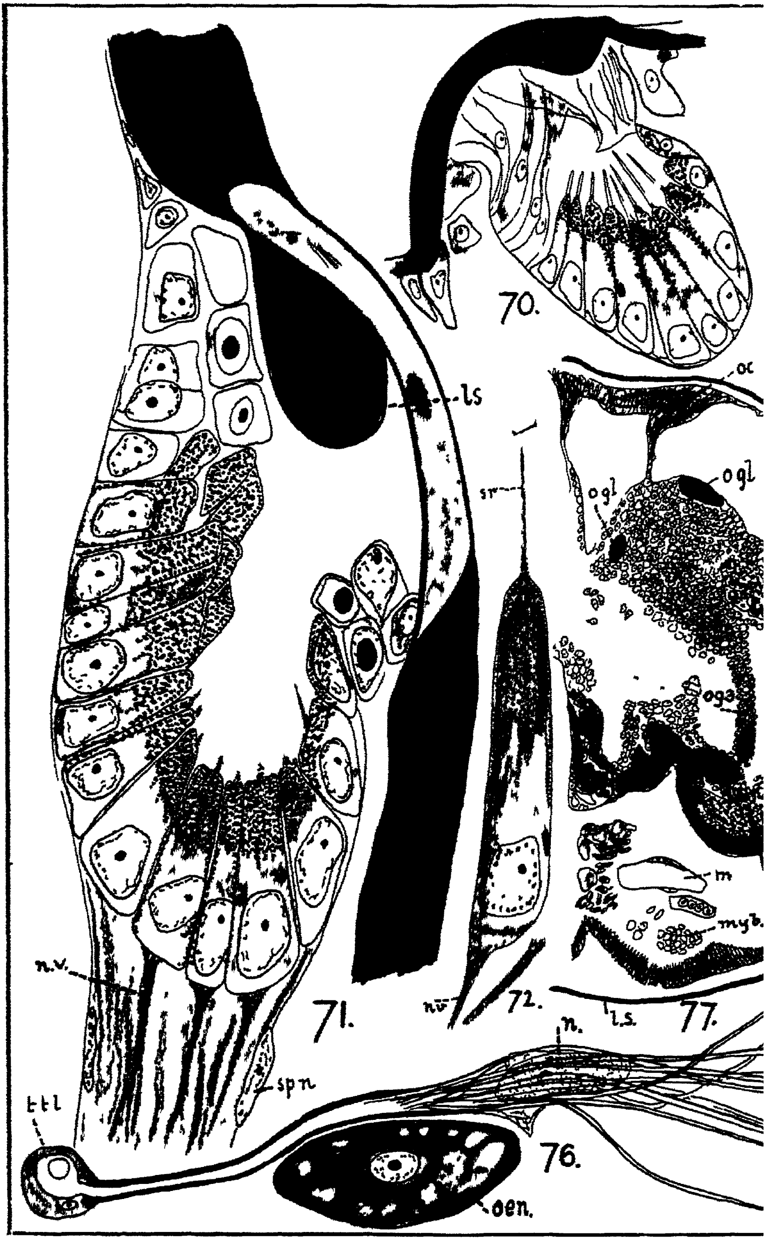
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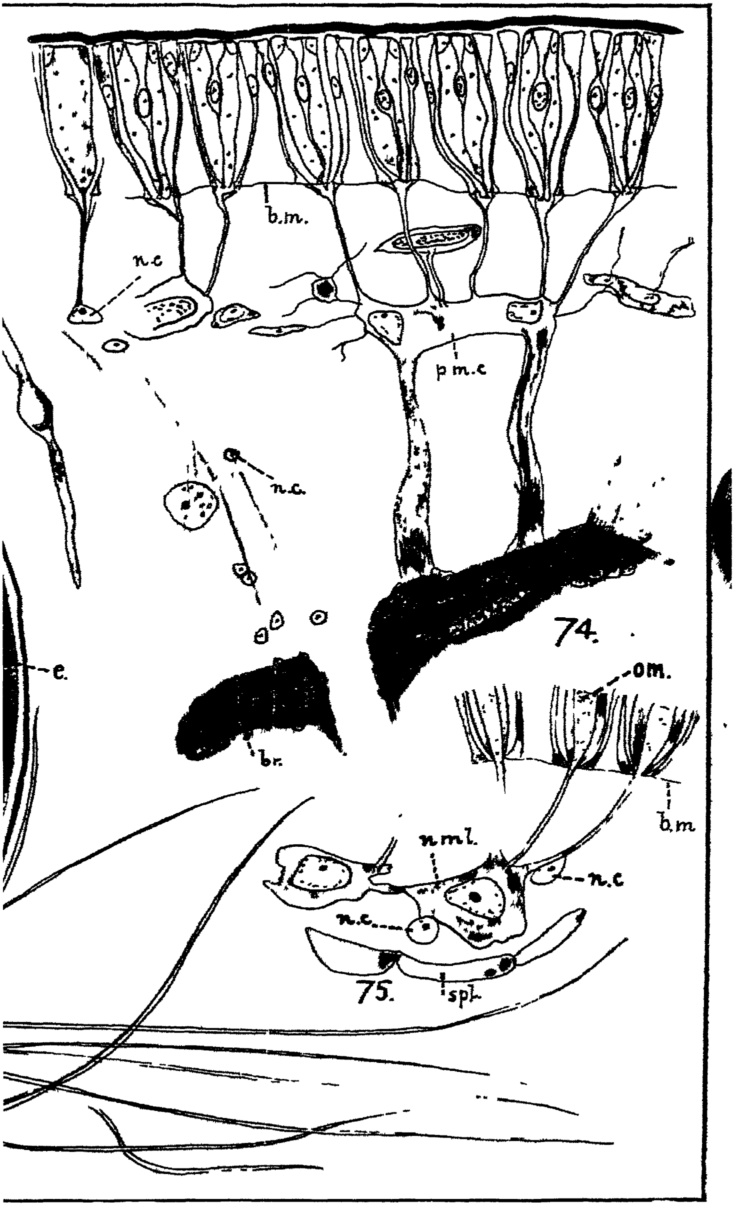

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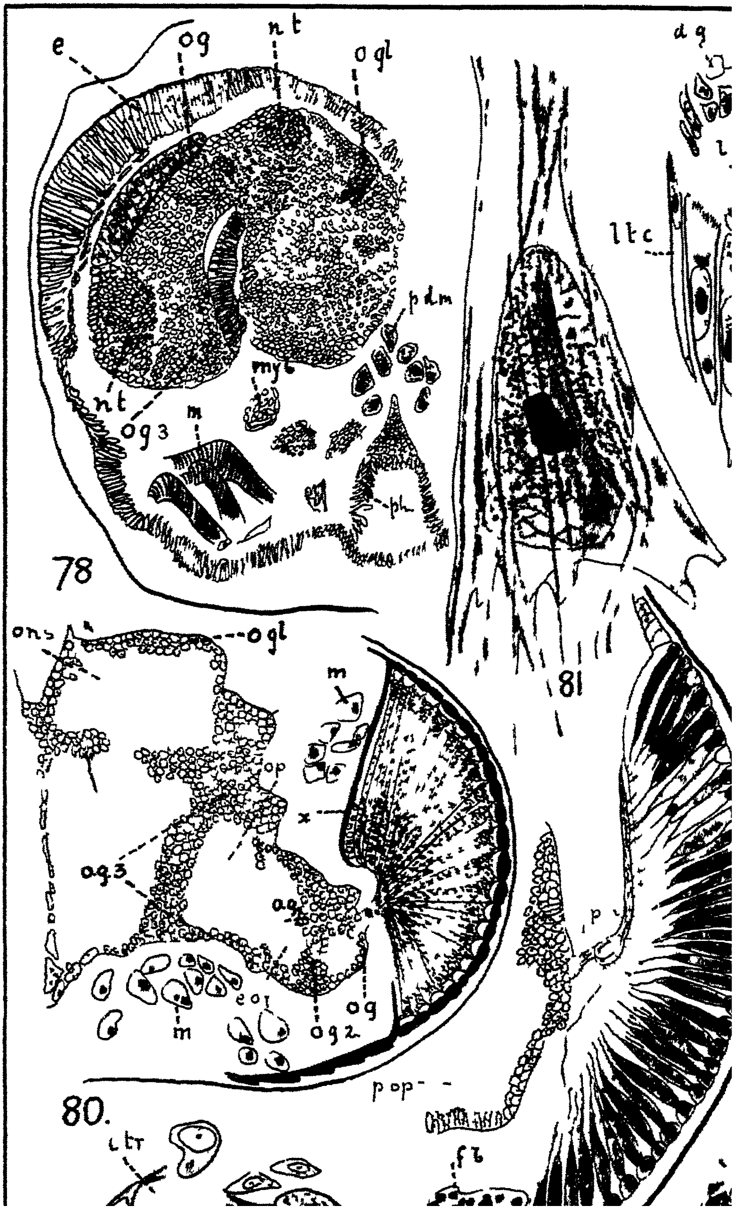
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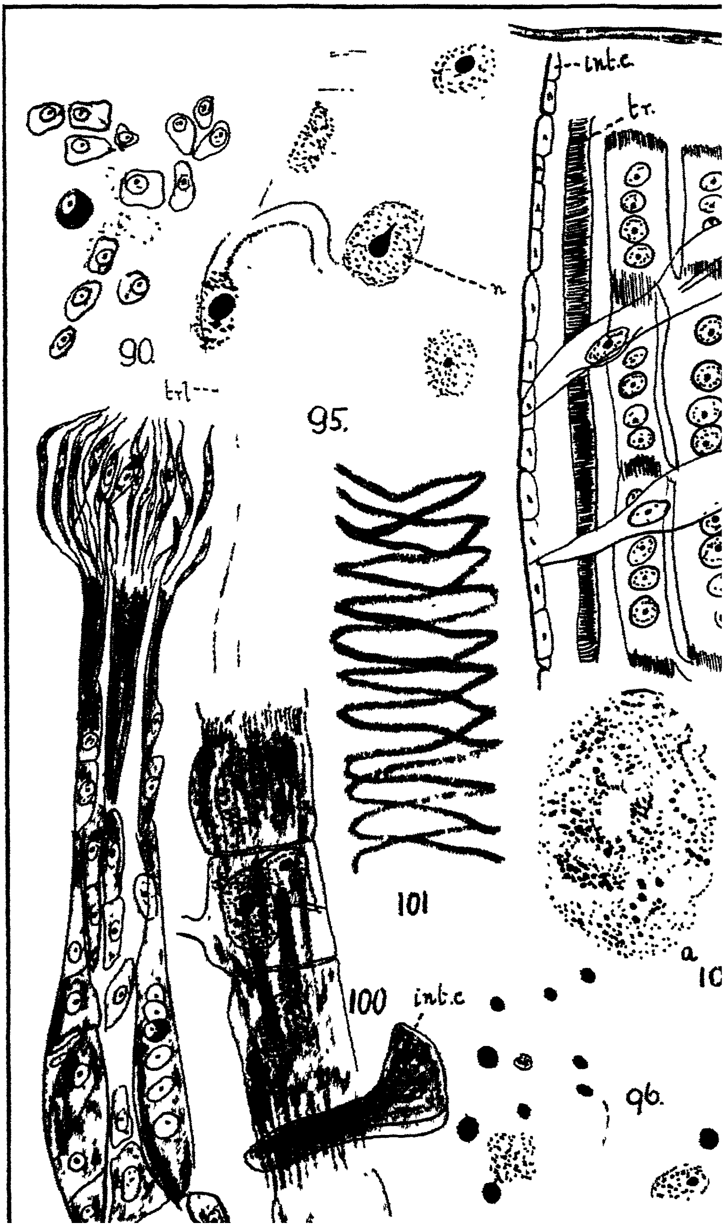
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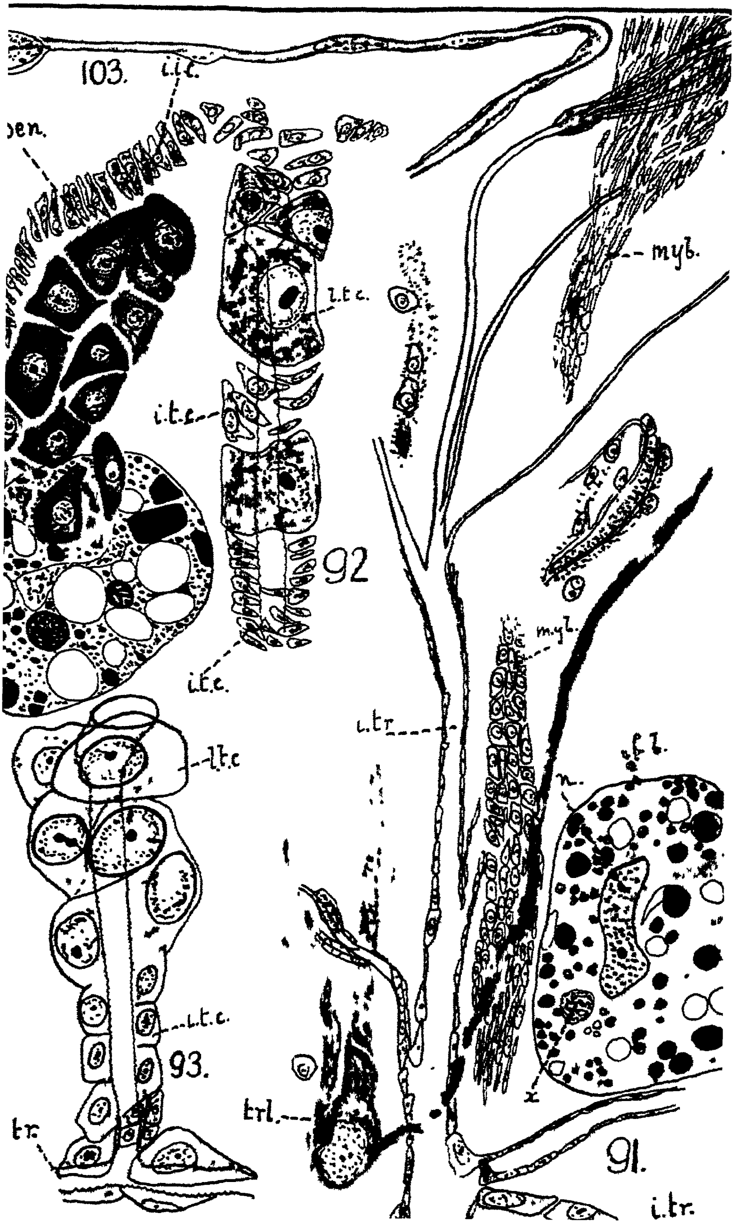
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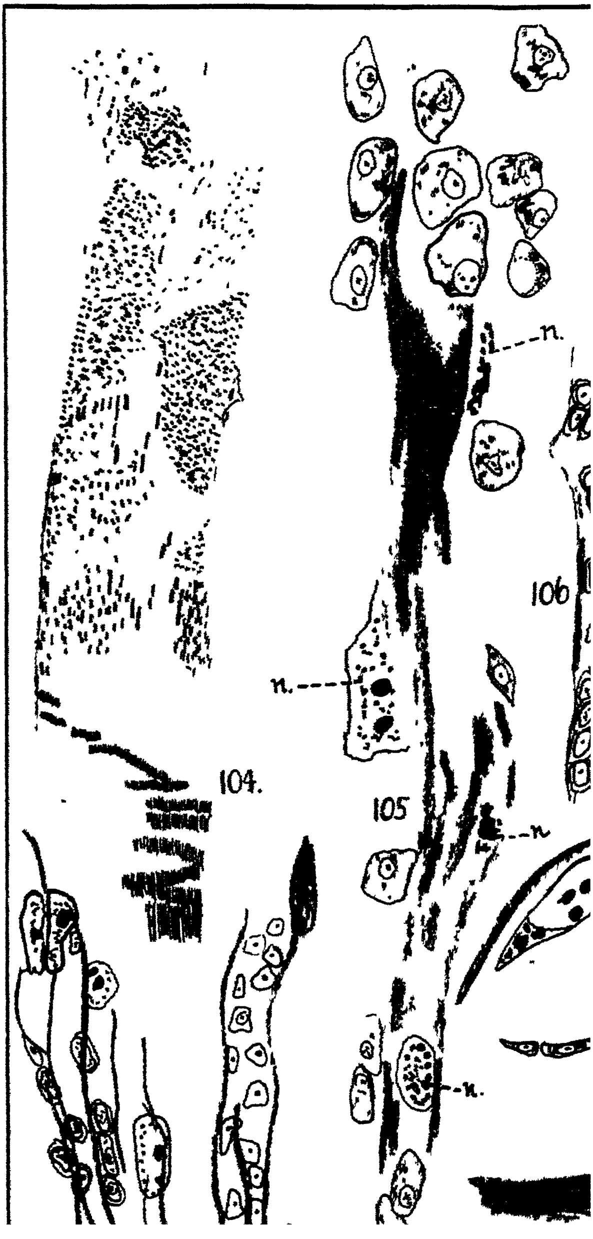
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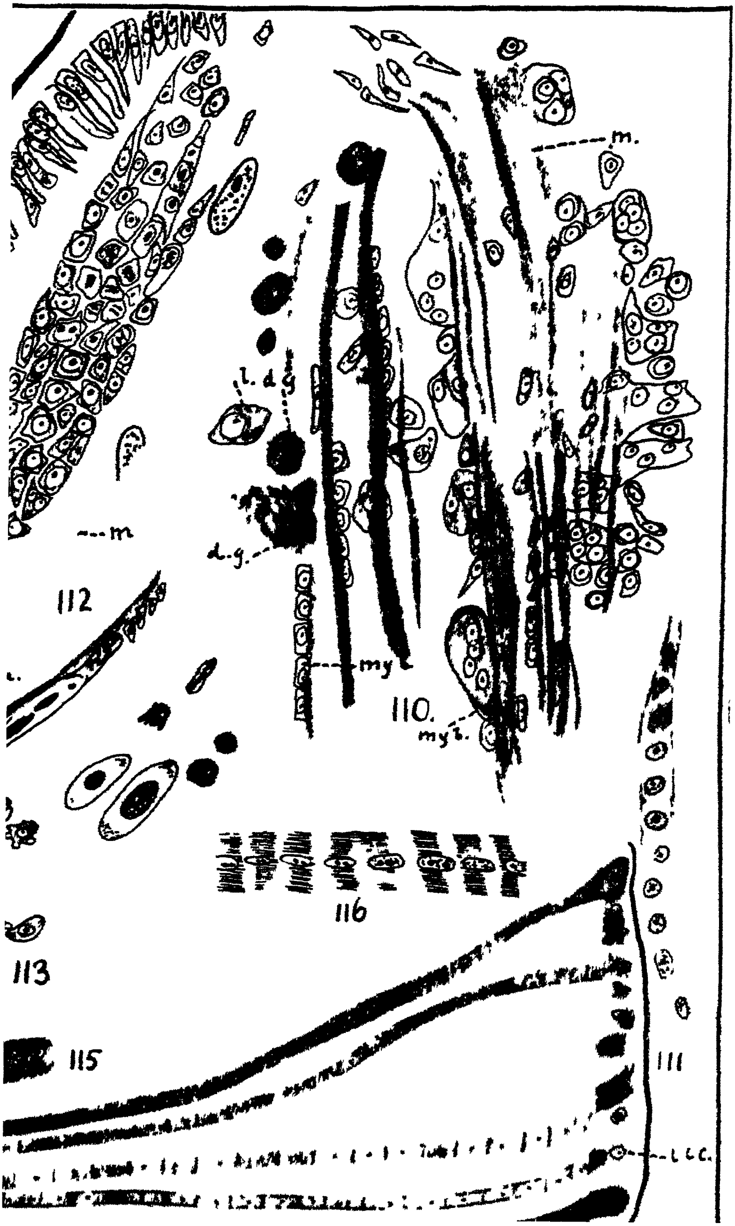
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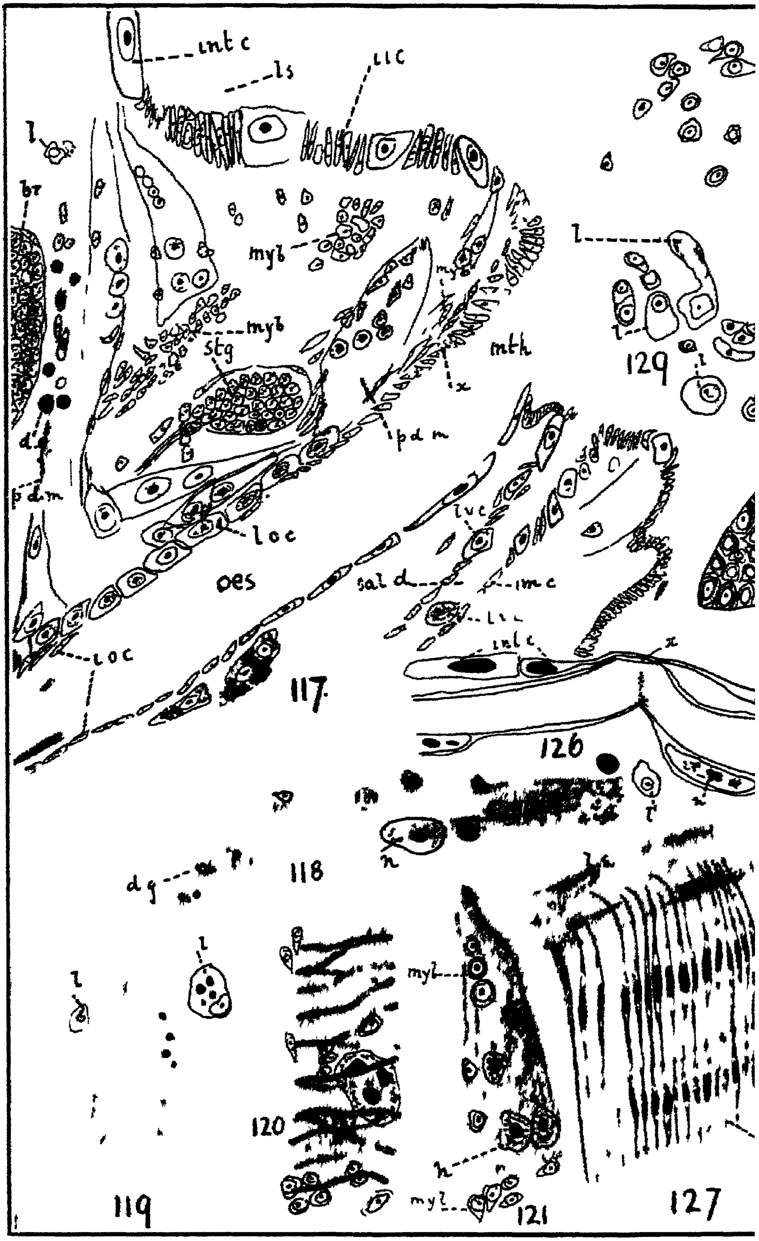
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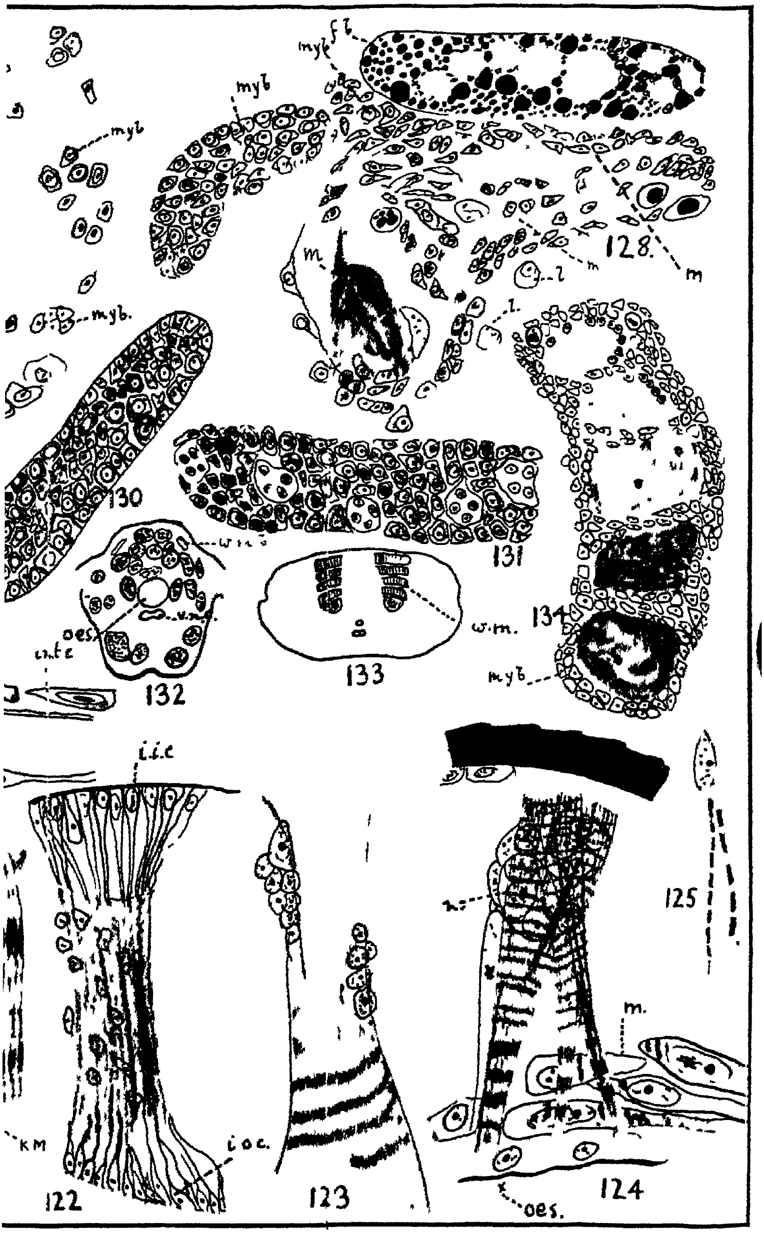
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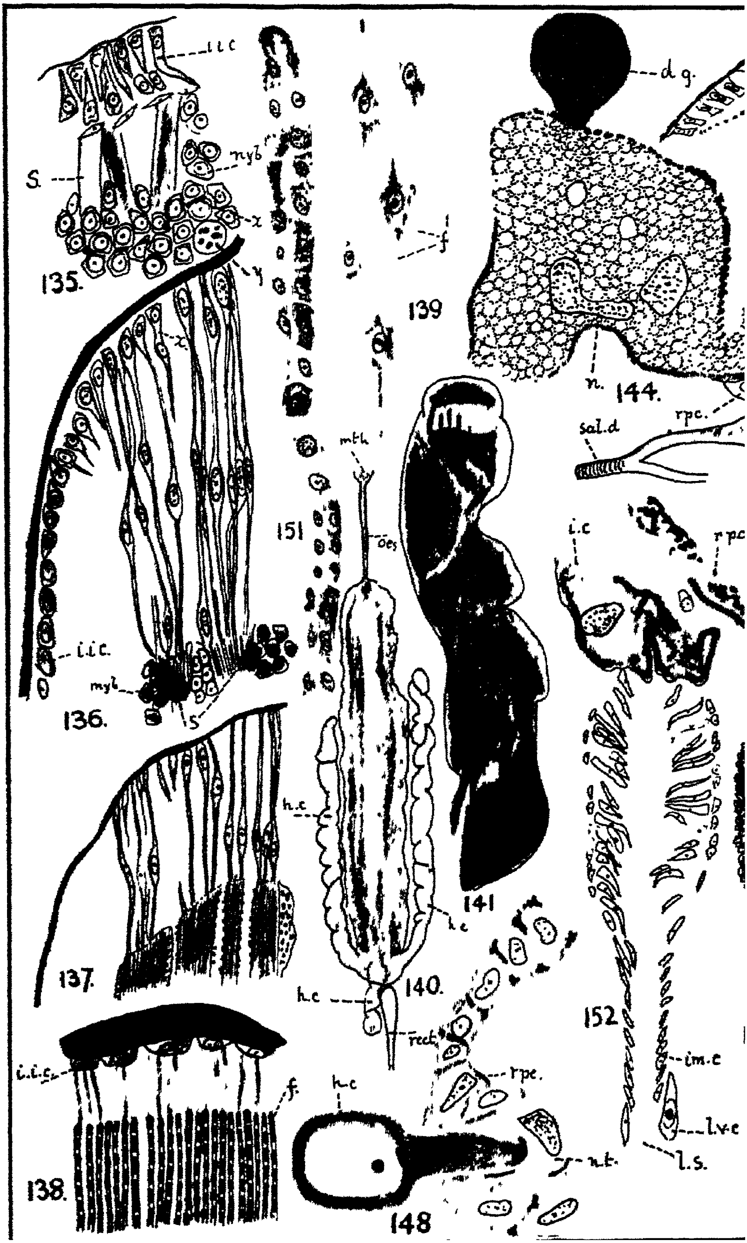
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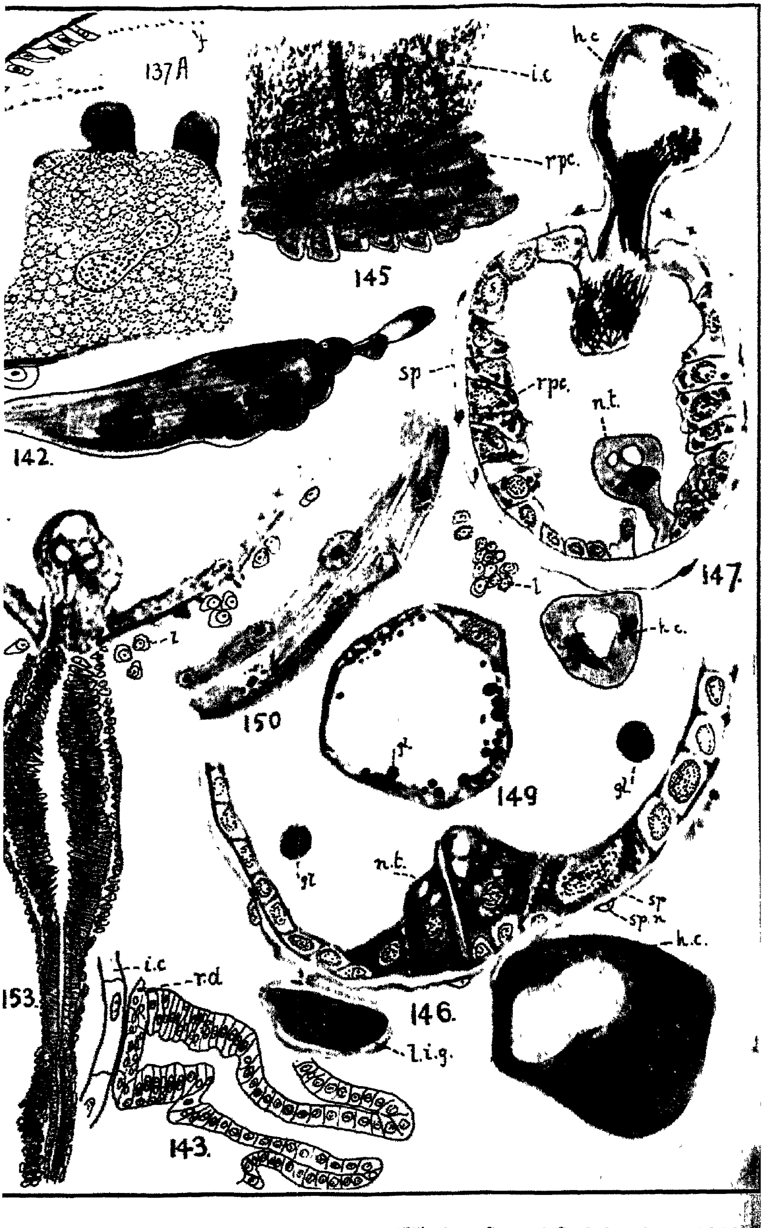

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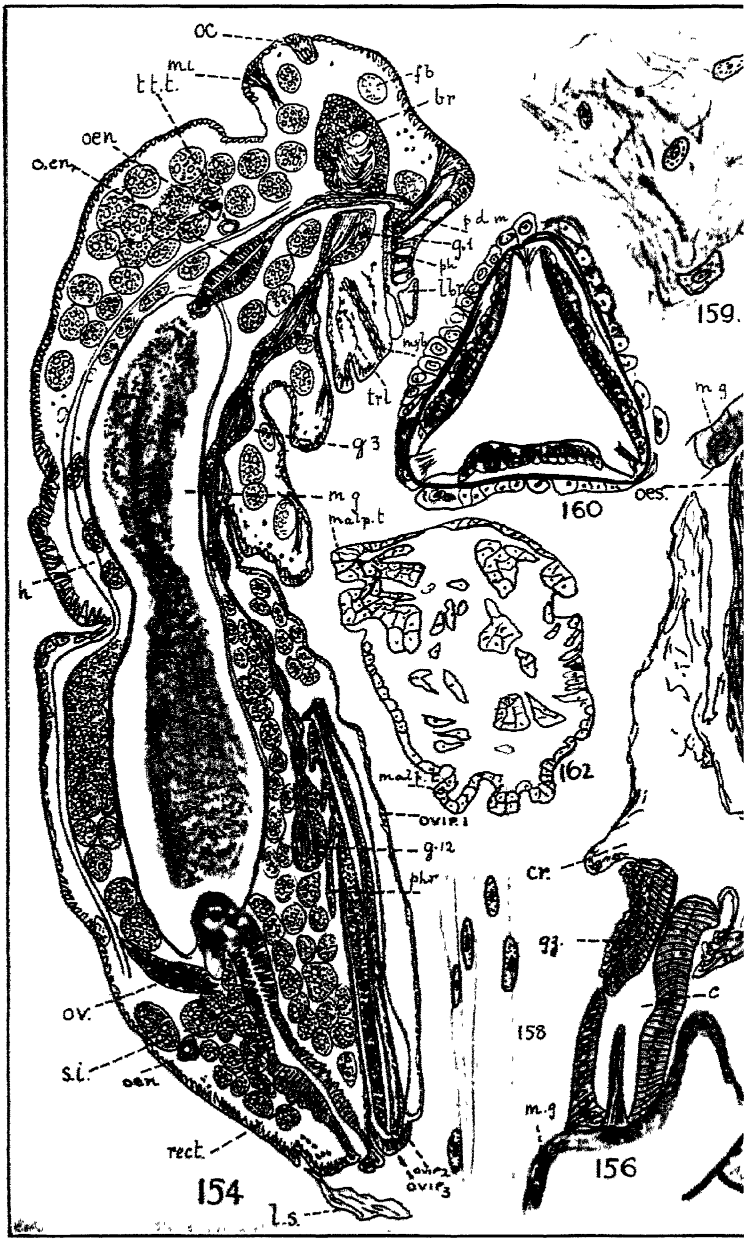
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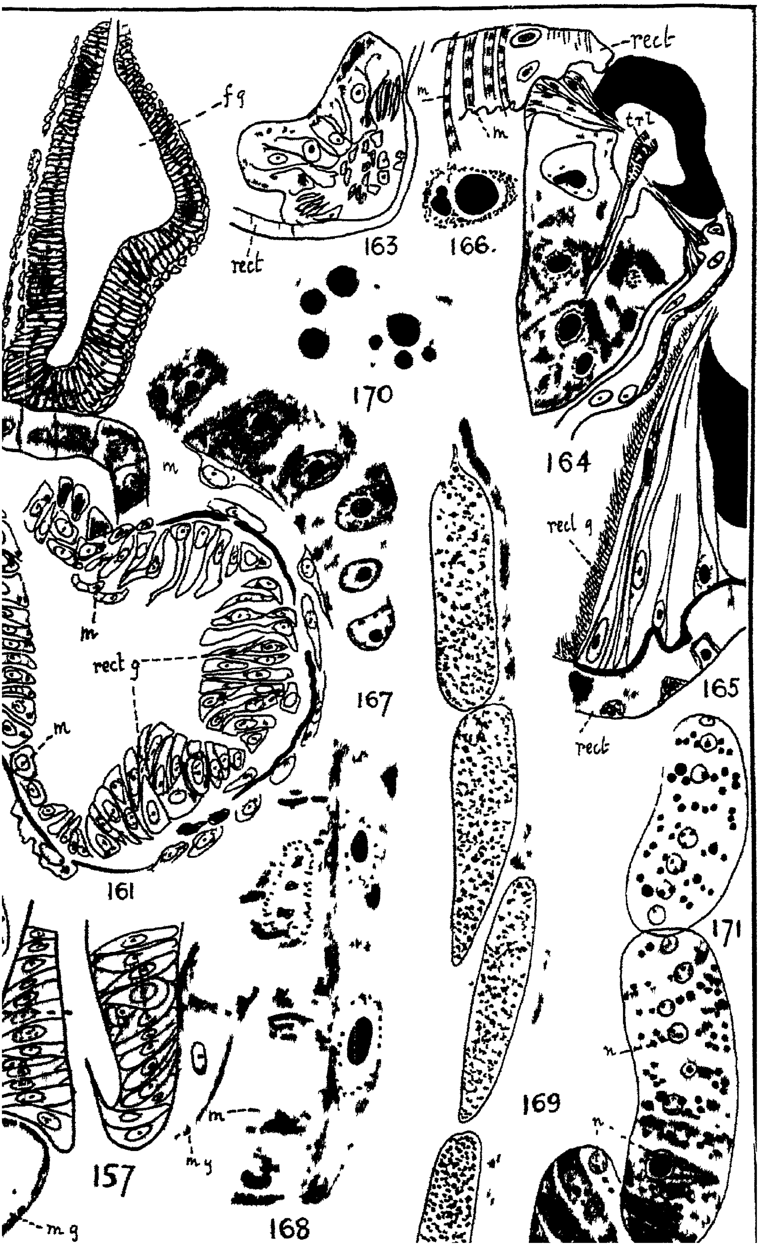
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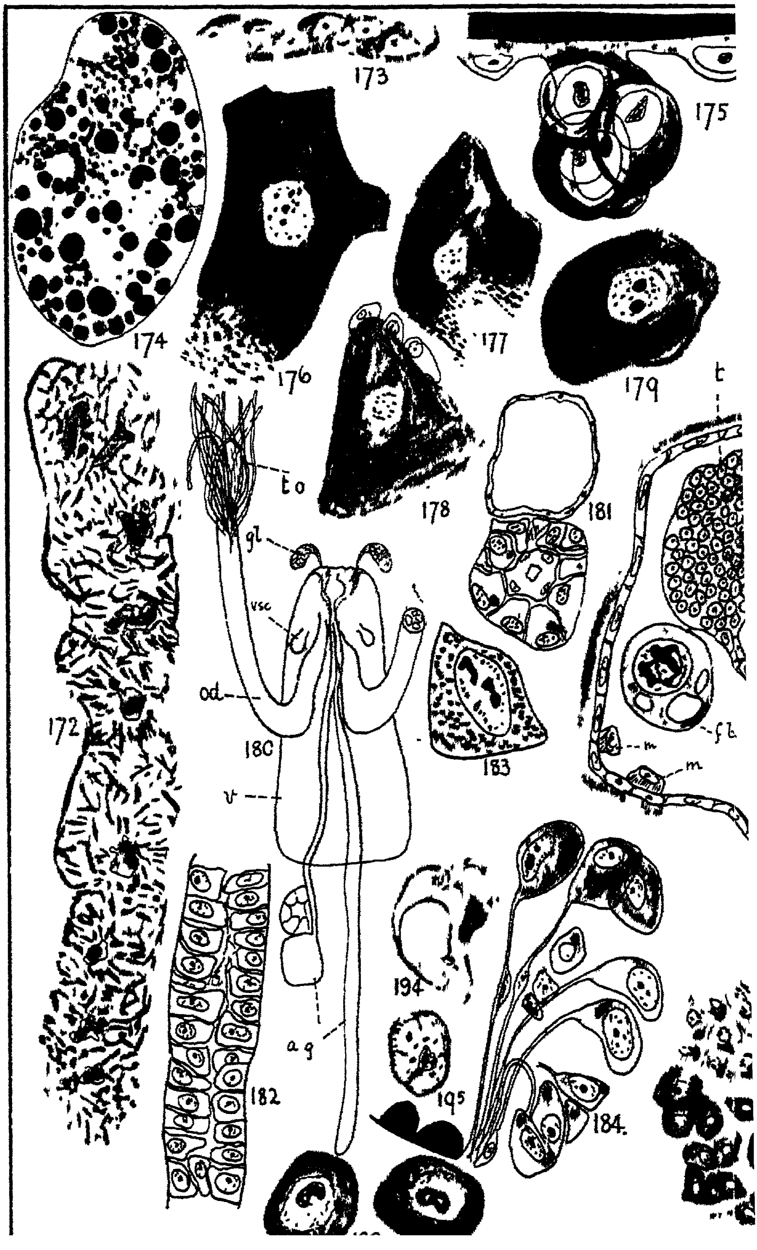
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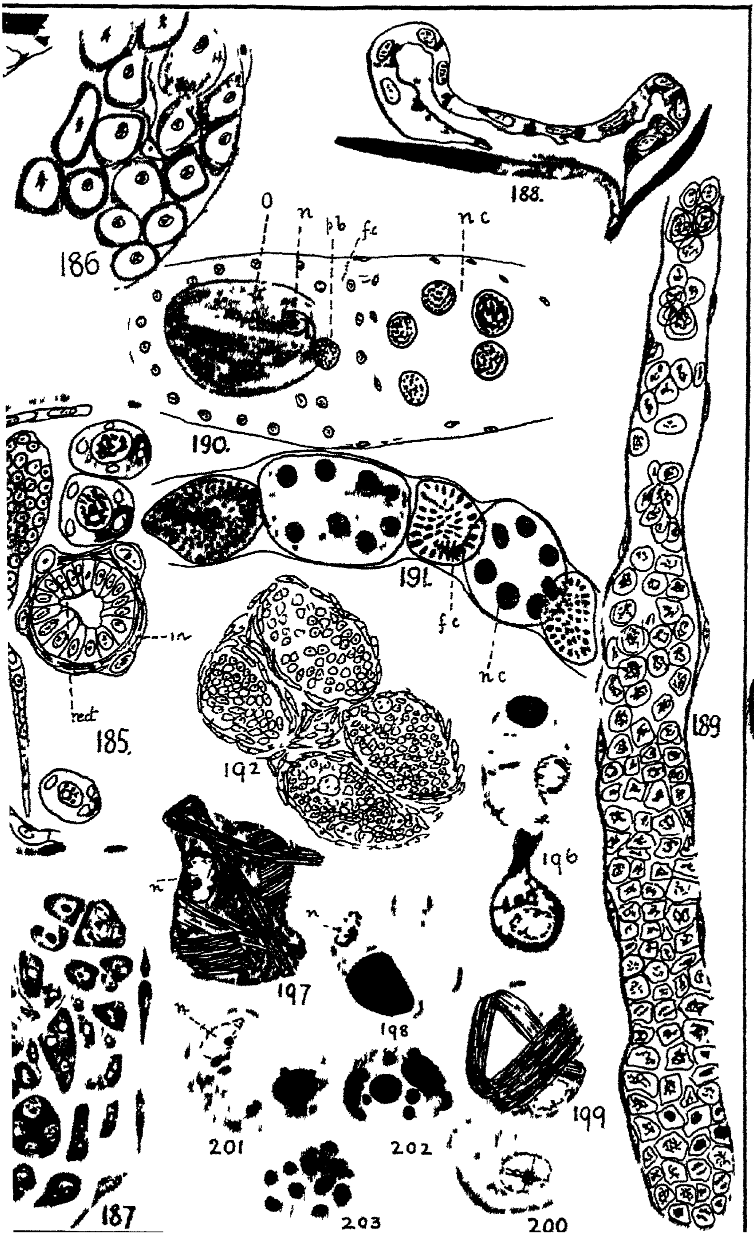
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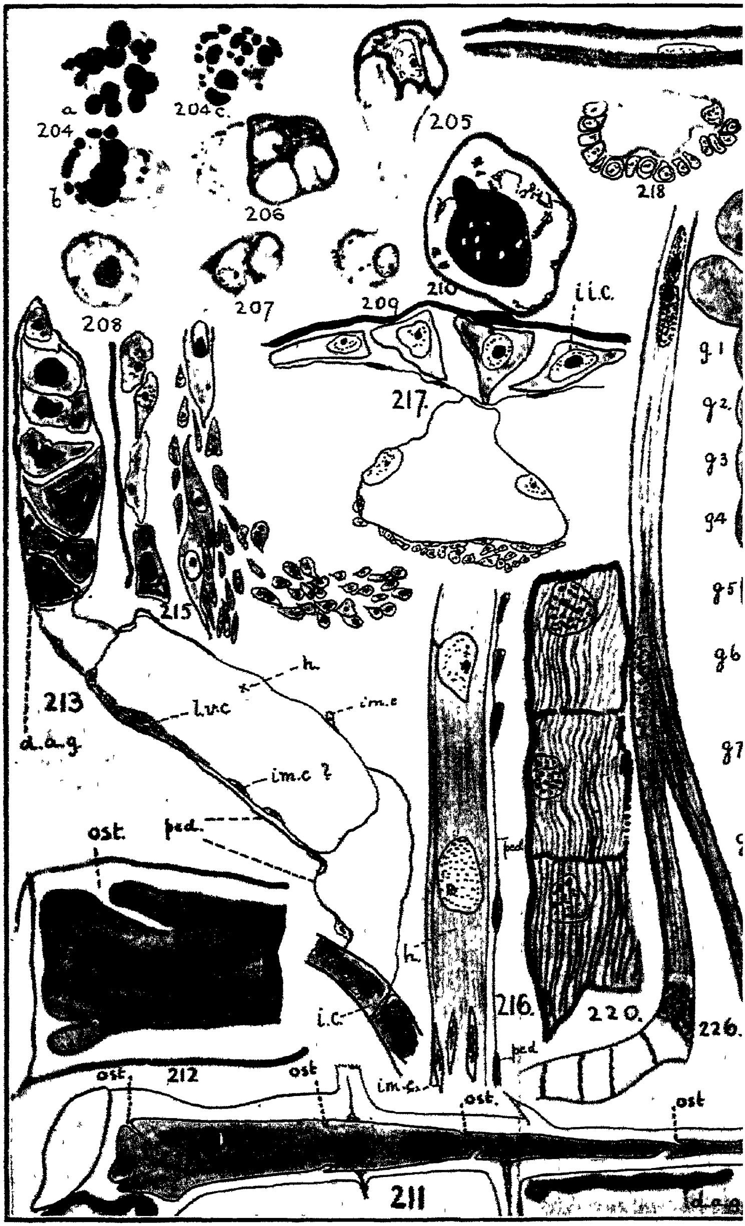
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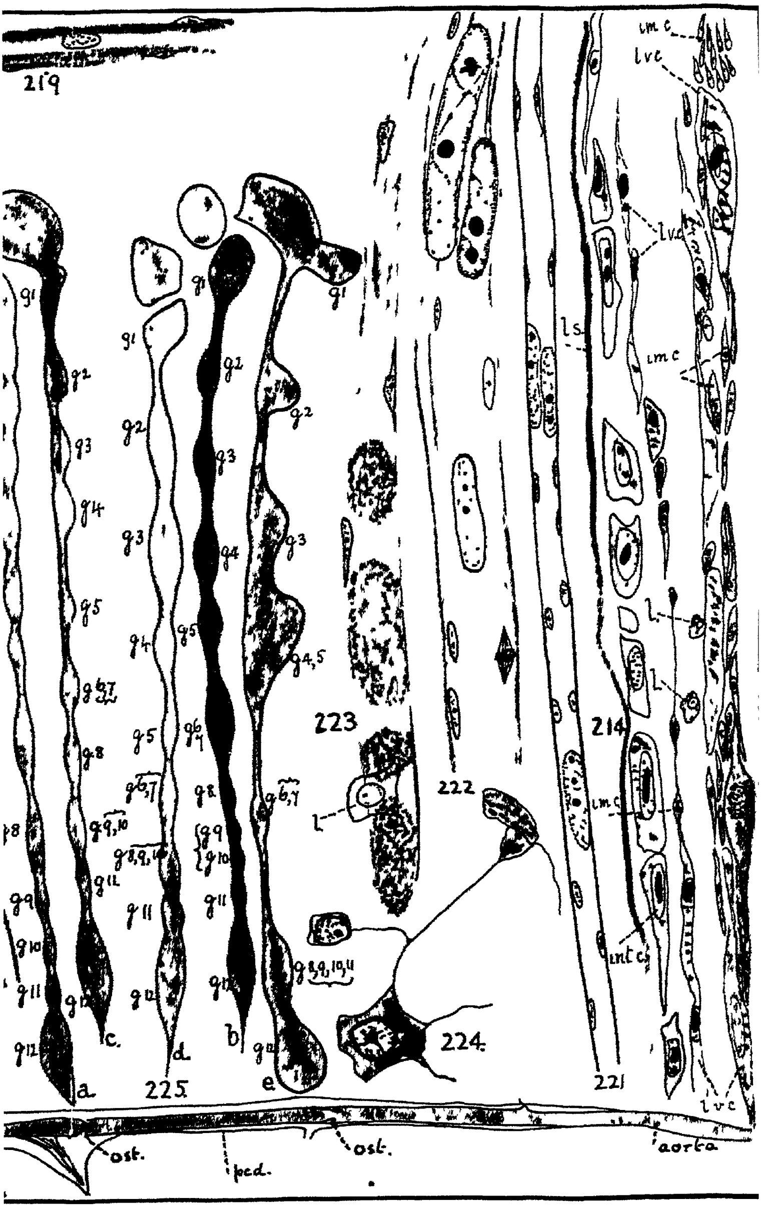

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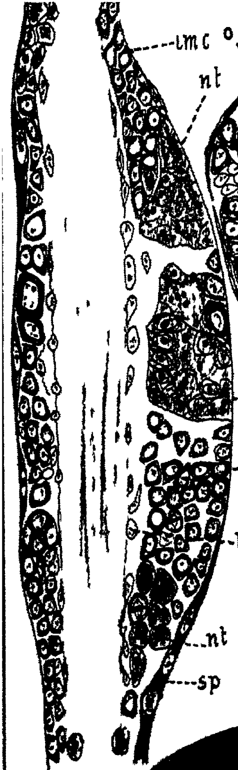

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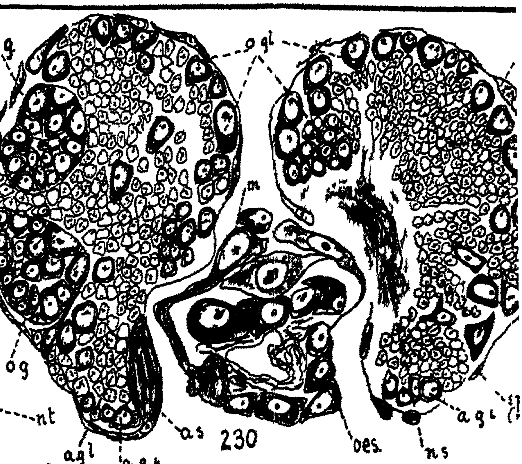

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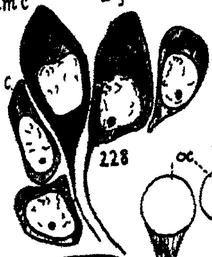

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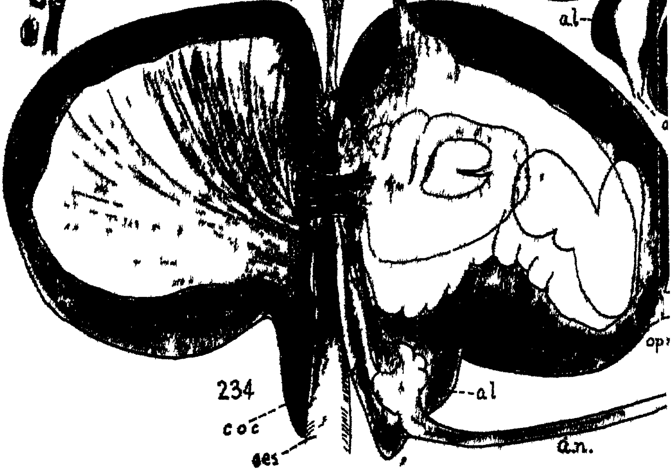

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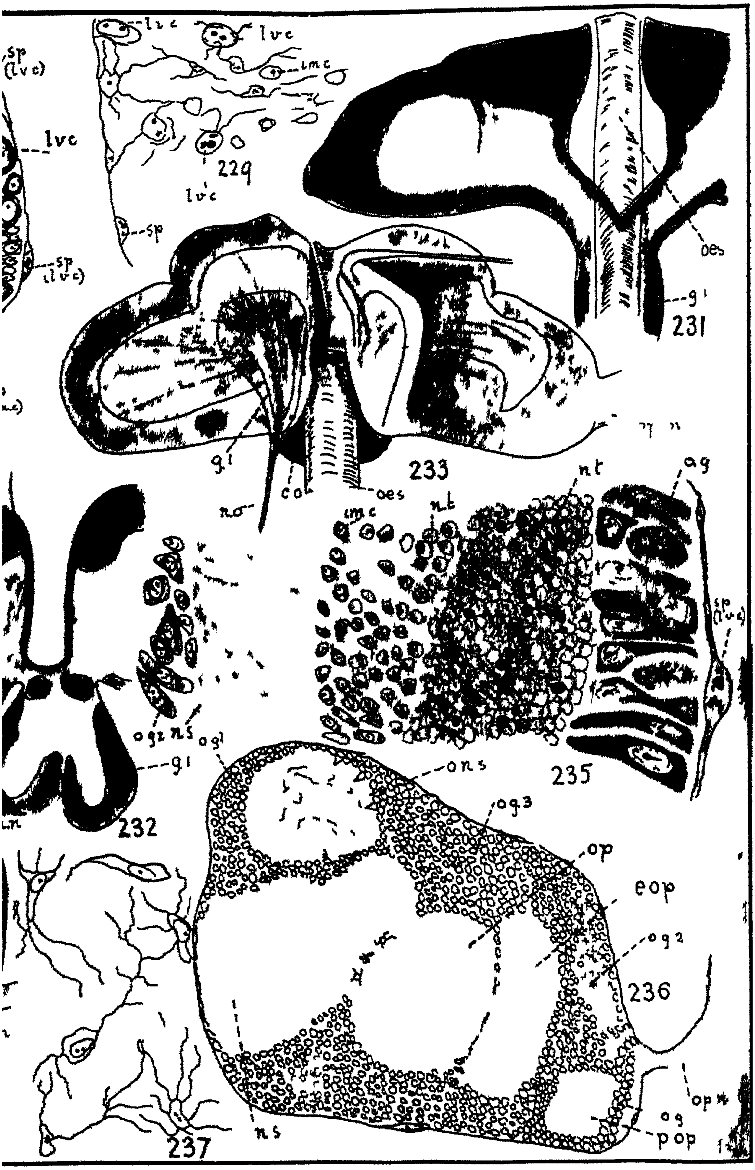

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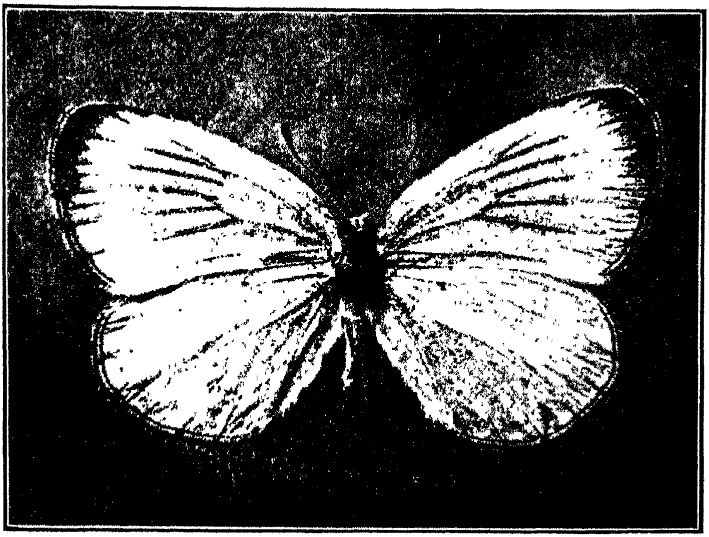

Fig. 1.

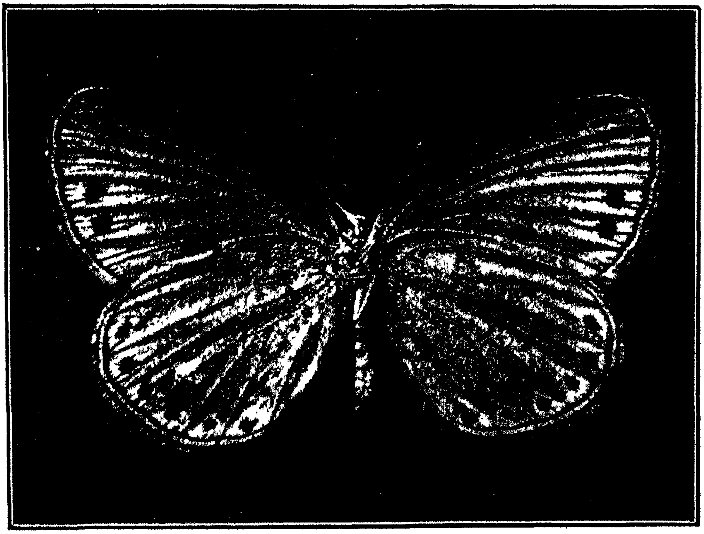

Fig. 2.

Adaluma urumelia, n. gen., et sp.

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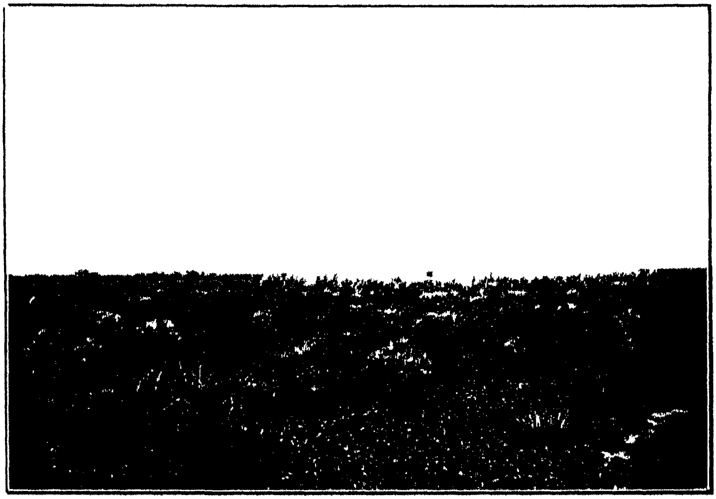

Fig. 1

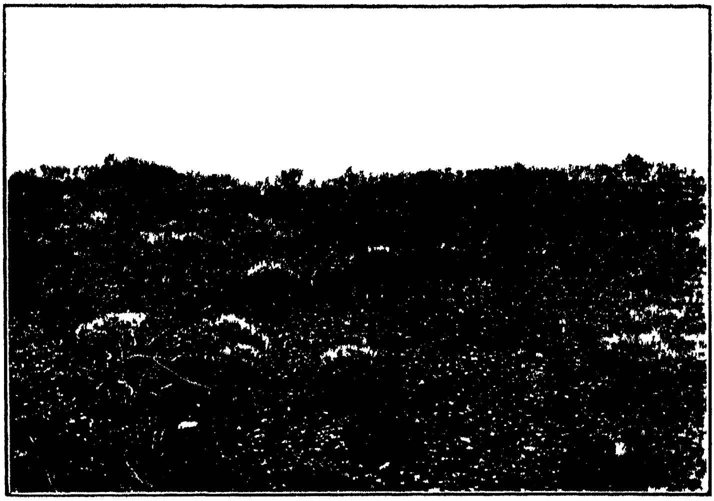

Fig. 2

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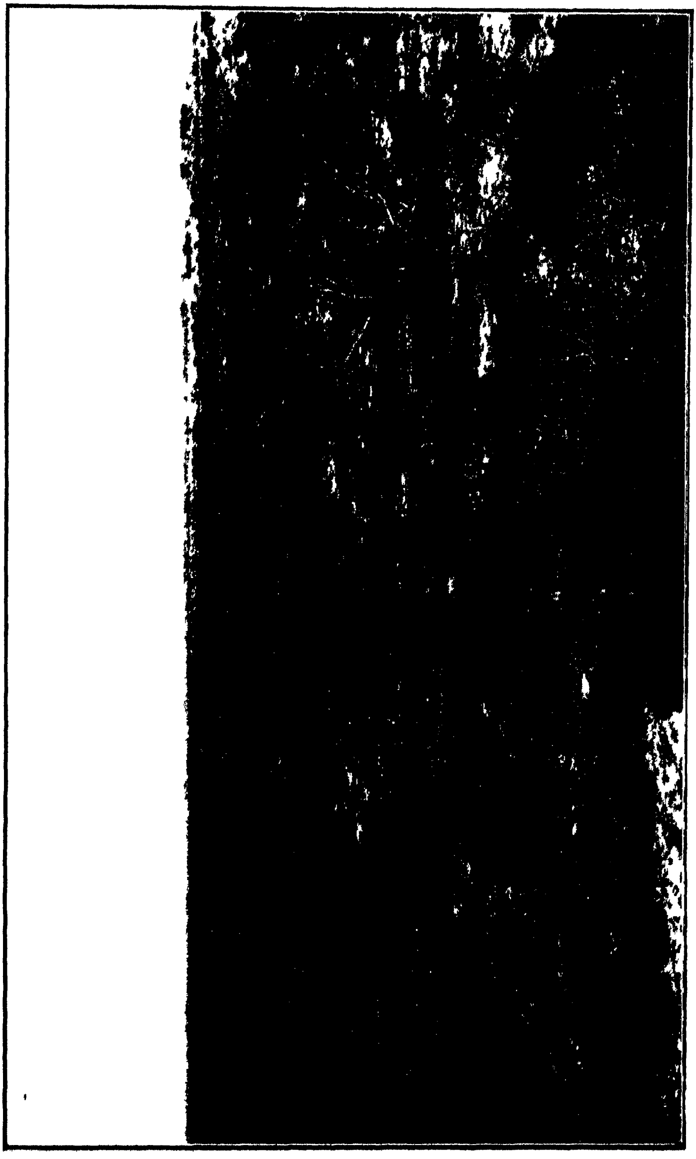


Gillingham Swann & Co Ltd, Printers, Adelaide

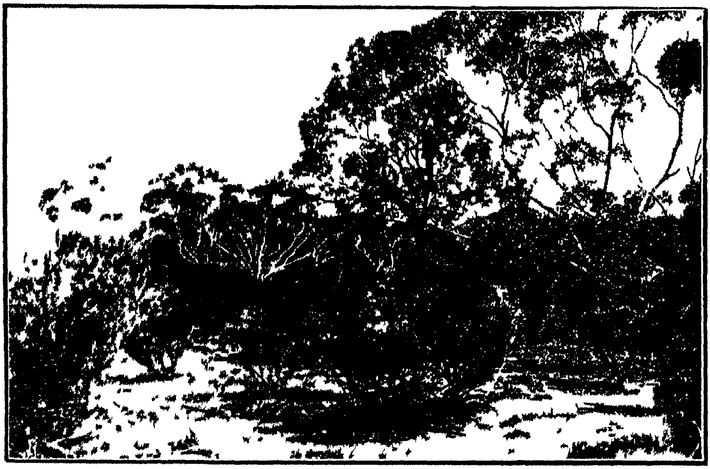


Fig. 1.

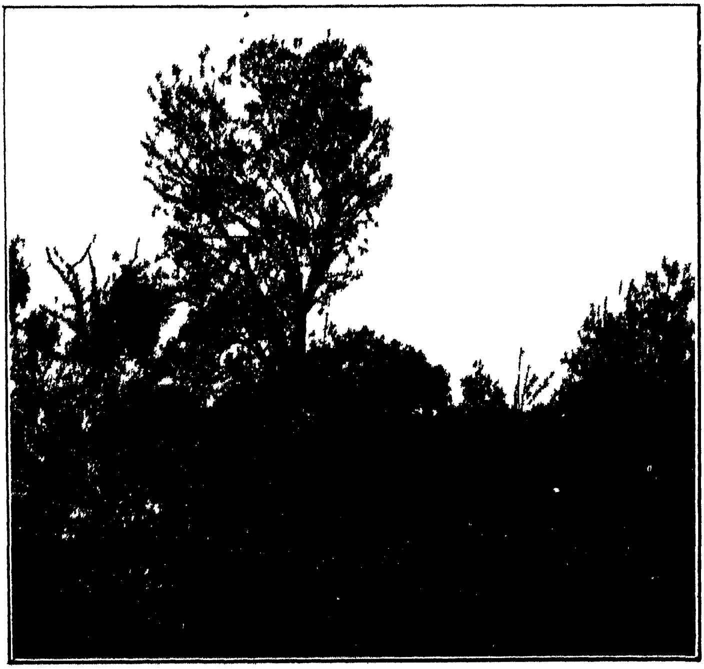
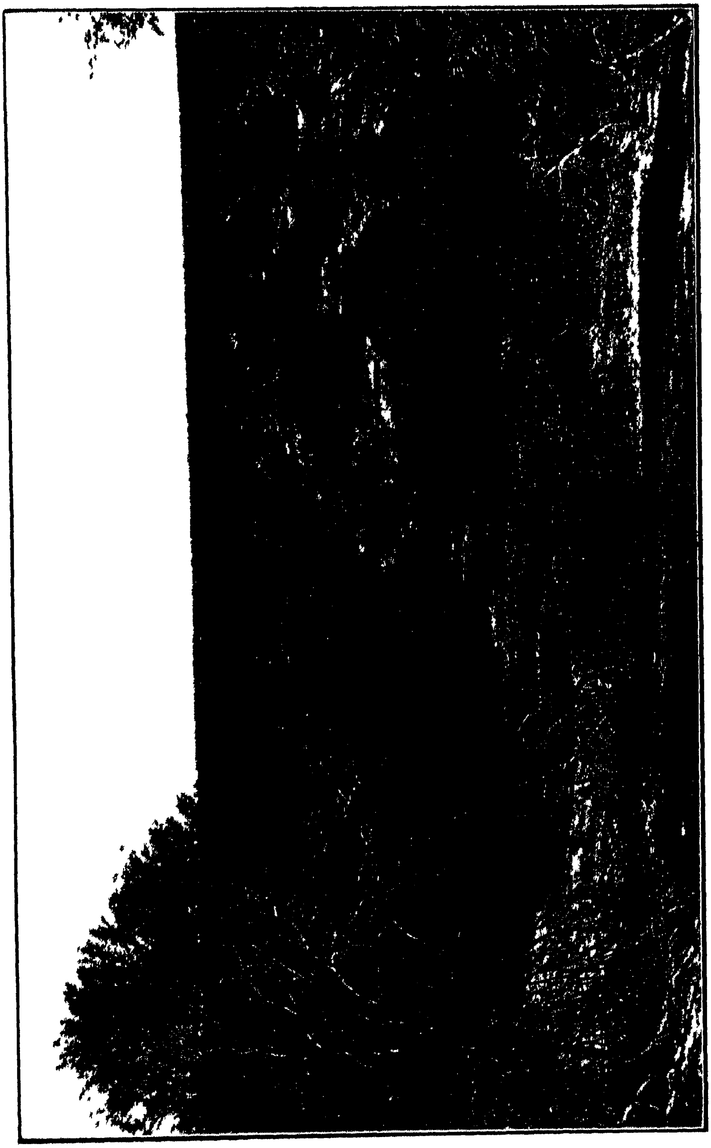


Fig. 2.

Gillingham, Swann & Co., Ltd., Printers, Adelaide.



Gillingham, Swann & Co. Ltd., Printers, Adelaide

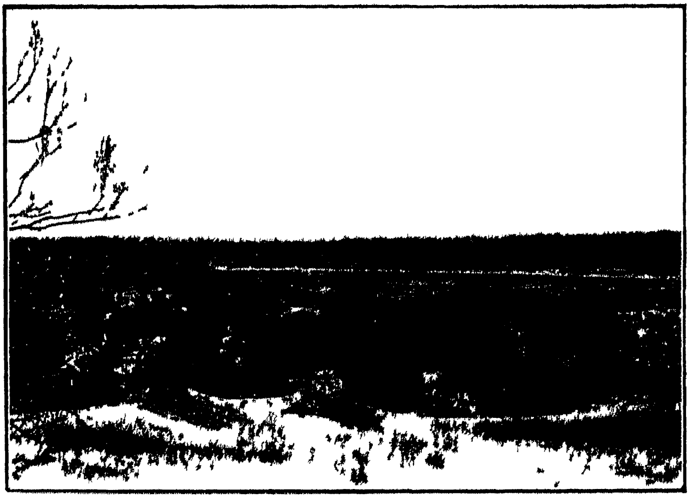
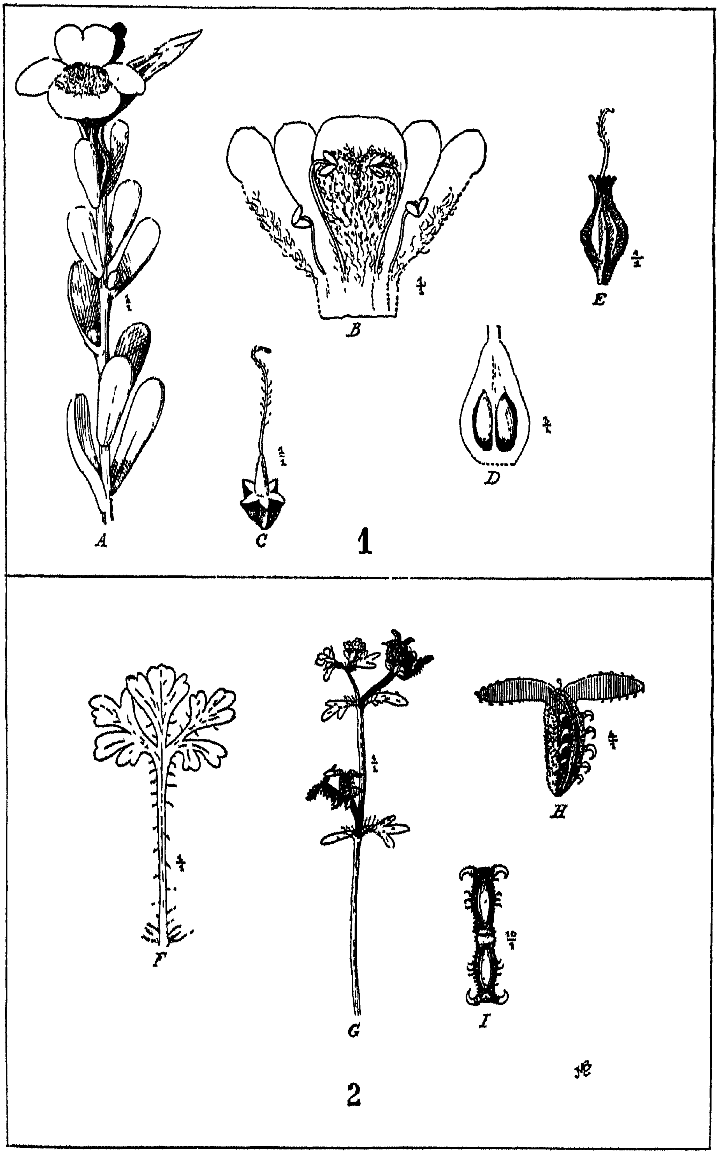


Fig 1

Fig 2

Gillingham Swann & Co Ltd, Printers Adelaide



1, *Eremophila pentaptera.* 2, *Uldinia mercurialis.*

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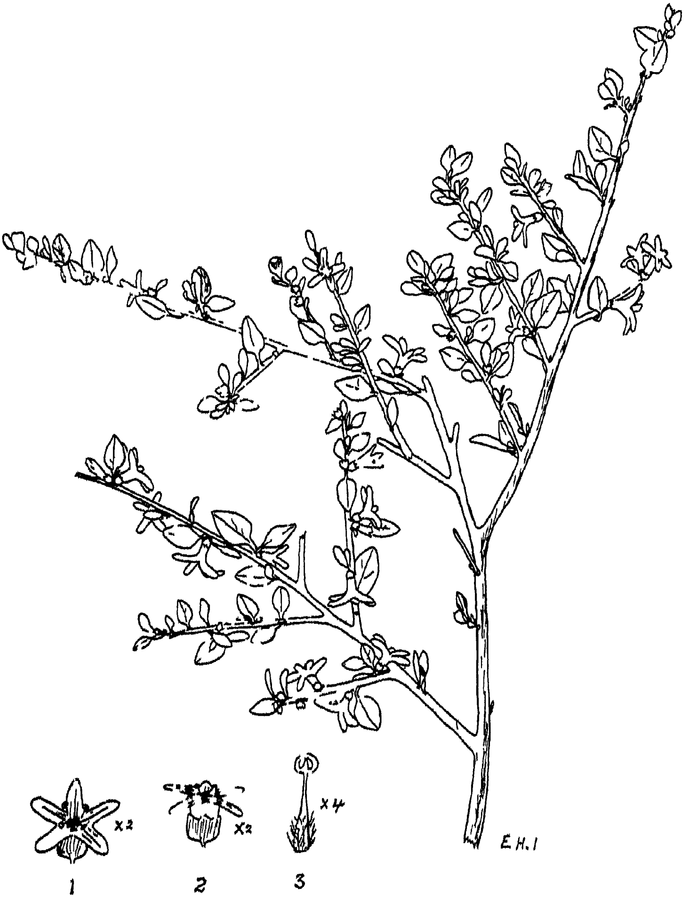

Anthotroche truncata, n.sp.

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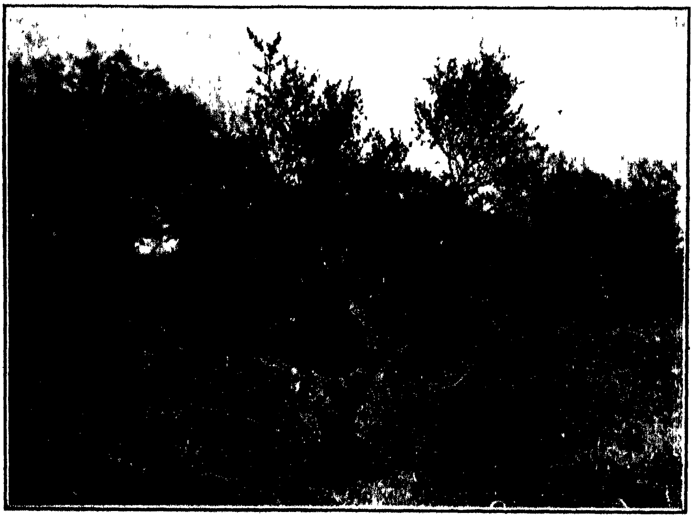

Fig. 1.

Fig. 2.

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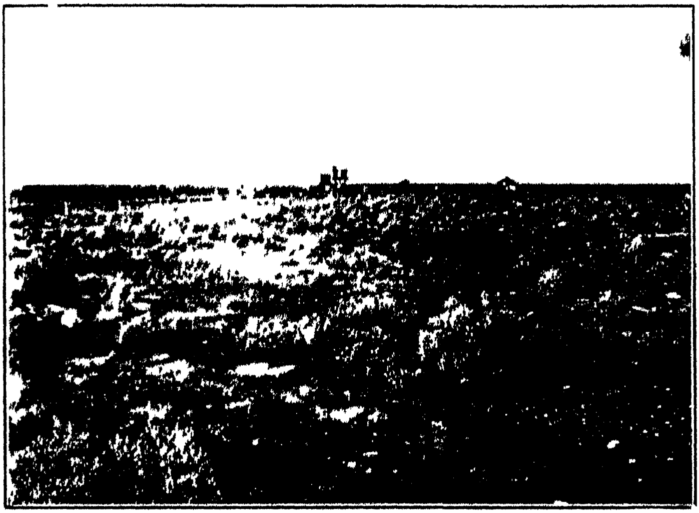

Fig. 1.

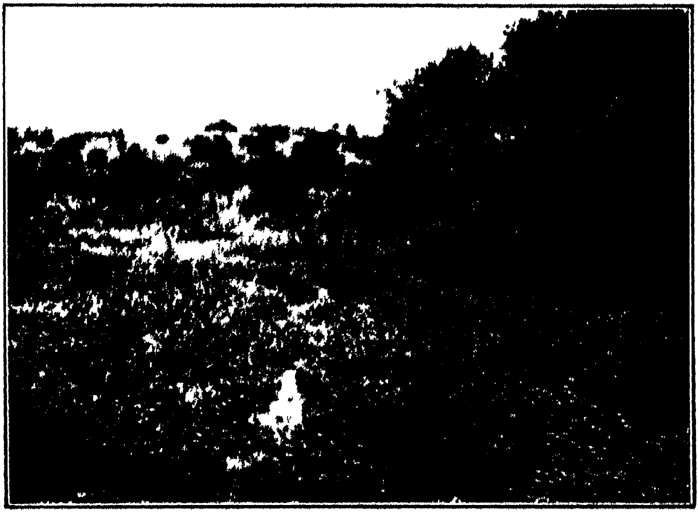

Fig. 2.

Gillingham, Swann & Co. Ltd., Printers, Adelaide

Fig. 1.

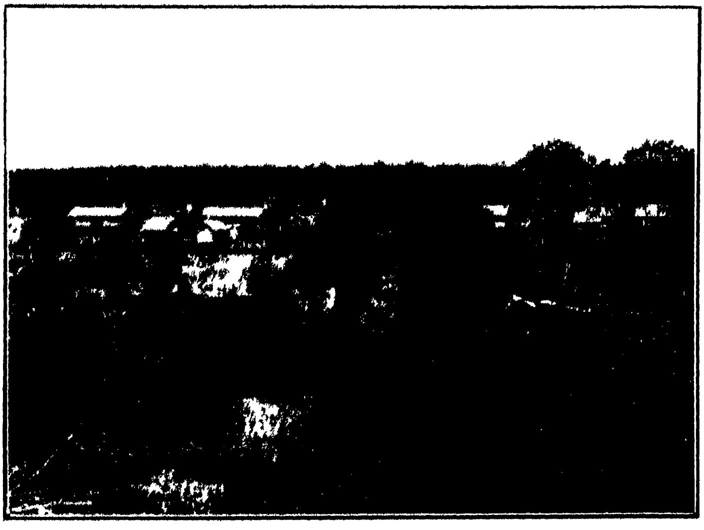

Fig. 2.

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